The Promise and Peril of Oil Shale Development (February 5) 2010

2-5-2010

SLIDES: The Elusive Bonanza

Randy Udall


The Elusive Bonanza

Yankee Ingenuity Will Capture the Prize


Chasing a
Mirage

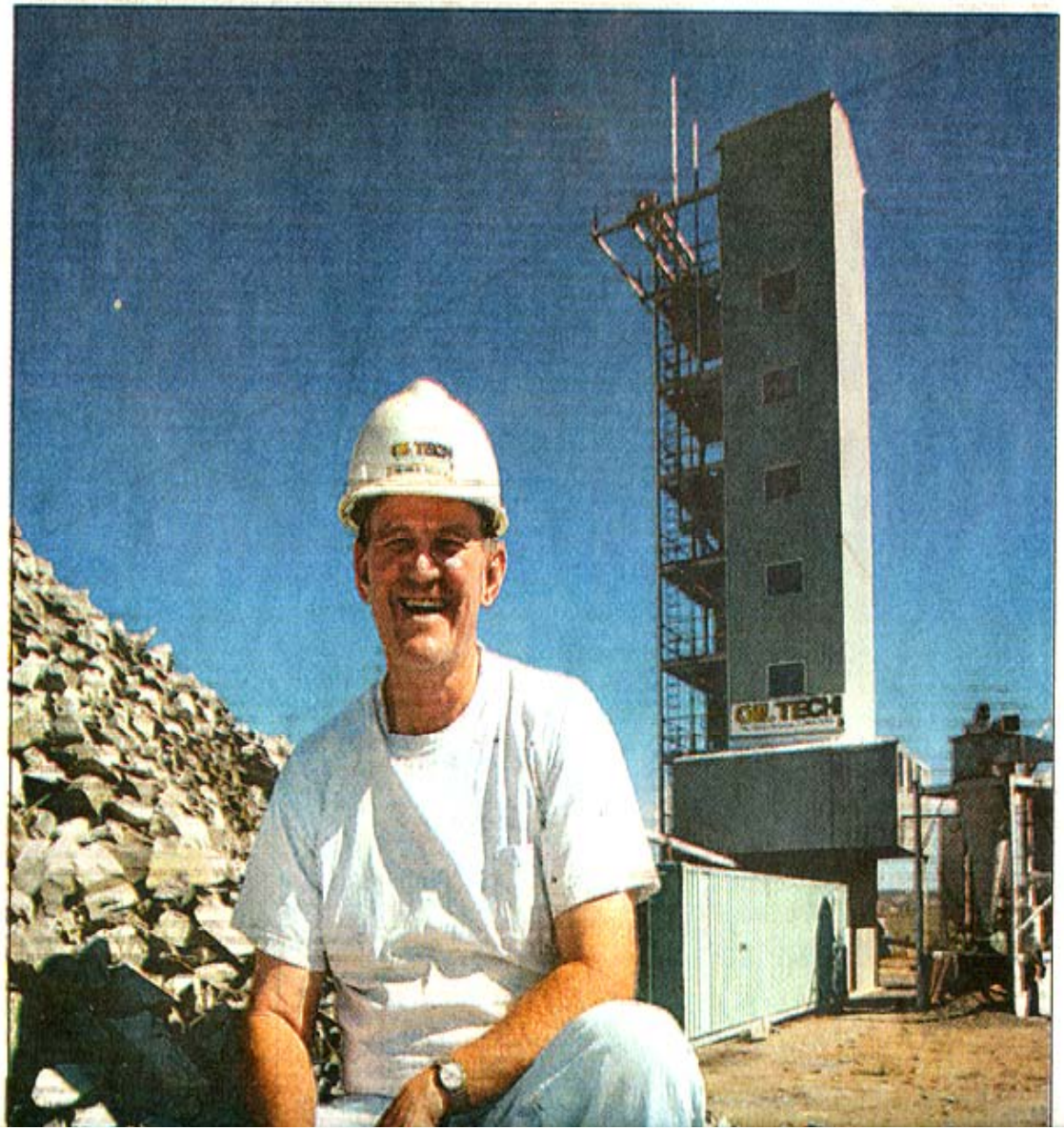
Decades of Quiet, Punctuated by Outbreaks of Hoopla and Hype

"An oil shale industry could be initiated by 2011 with initial production of 200,000 b/pd, with an aggressive goal of 2 million b/pd by 2020. Ultimate capacity could reach 10 million b/pd…"

--2004 report funded by the U.S. Department of Energy

‘Colorado Oil Shale Follies’: Long play starring dreamers, hucksters, gullible reporters, deluded federal officials, local boosters, stock swindlers, dedicated engineers and one Black Sunday

Oil riches just out of reach



Shell leads push on shale

Rising crude prices boost hopes for the success of inserting heating rods into layers of rock to extract the West's estimated reserves of 1 trillion barrels.

Part 1 of two stories about prospects for the oil shale industry on Colorado's Western Slope. Part 2 will appear in Tuesday's Denver Post business section.

By Paul Foy
The Associated Press

Meeker — Out in sagebrush country, Kenneth Brown is standing over part of the world's most concentrated energy resource, land that holds up to 1 million barrels of oil per acre.

Too bad it's locked up in layers of rock in some places hundreds of feet underground.

Such is the dilemma presented by the West's oil shale reserves, believed to contain more than 1 trillion barrels of oil — four times the holdings of Saudi Arabia, according to government and industry estimates.

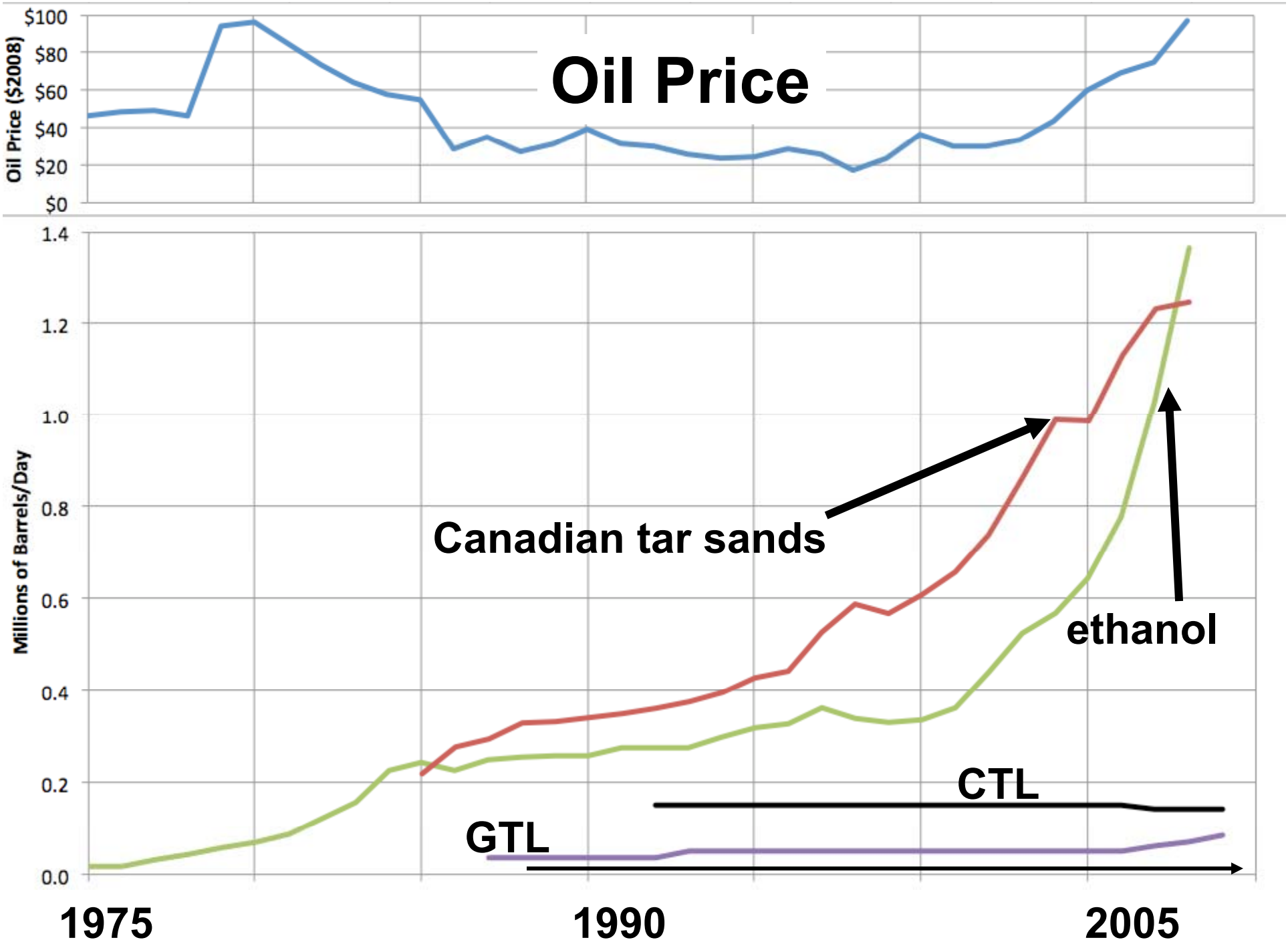
The problem is extraction: Underground layers of shale are as thick as 1,000 feet and were deposited over millions of years by an algae-producing sea. The Green River formation is potentially the world's most bountiful energy source — enough in theory to meet U.S. energy needs for a century — but it is an expensive nut to crack for energy companies. Plus, it could use up a lot of water in an arid region.

Shell Exploration & Production Co. has been out here for nine years, trying to bake shale oil from the ground by using heating

> See **OIL SHALE** on 5E

Mining oil reserves with heat

The oil industry is considering using heat technology to mine the West's oil shale reserves, which are believed to contain more than


Oil Price
Oil Price ($2008)
$100
$80
$60
$40
$20
$0
Millions of Barrels/Day
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Canadian tar sands
ethanol
CTL
GTL
1975
1990
2005

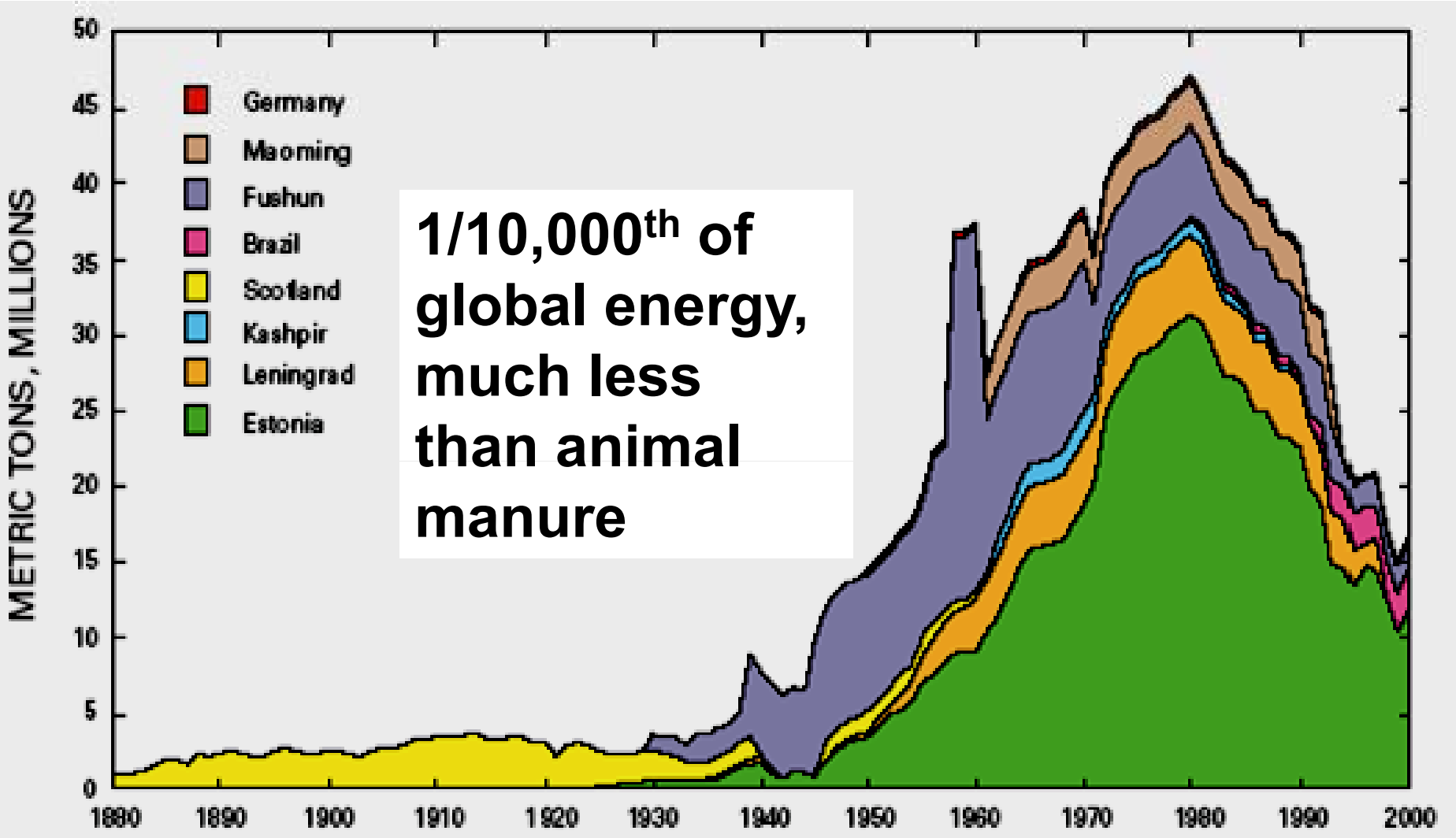


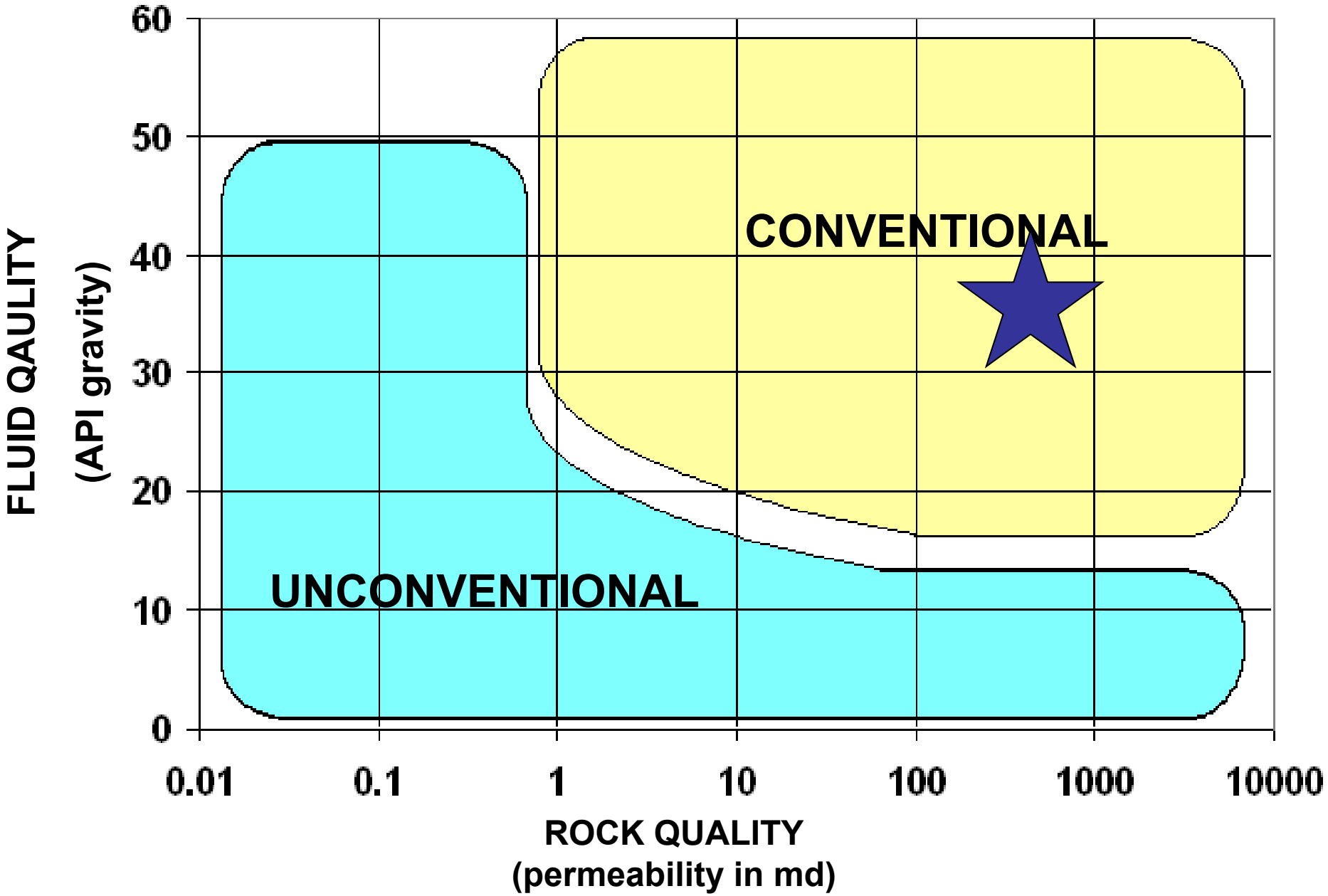
Figure 19. Production of oil shale in millions of metric tons from Estonia (Estonia deposit), Russia (Leningrad and Kashpir deposits), United Kingdom (Scotland, Lothians), Brazil (Irati Formation), China (Maoming and Fushun deposits), and Germany (Dotternhausen) from 1880 to 2000.

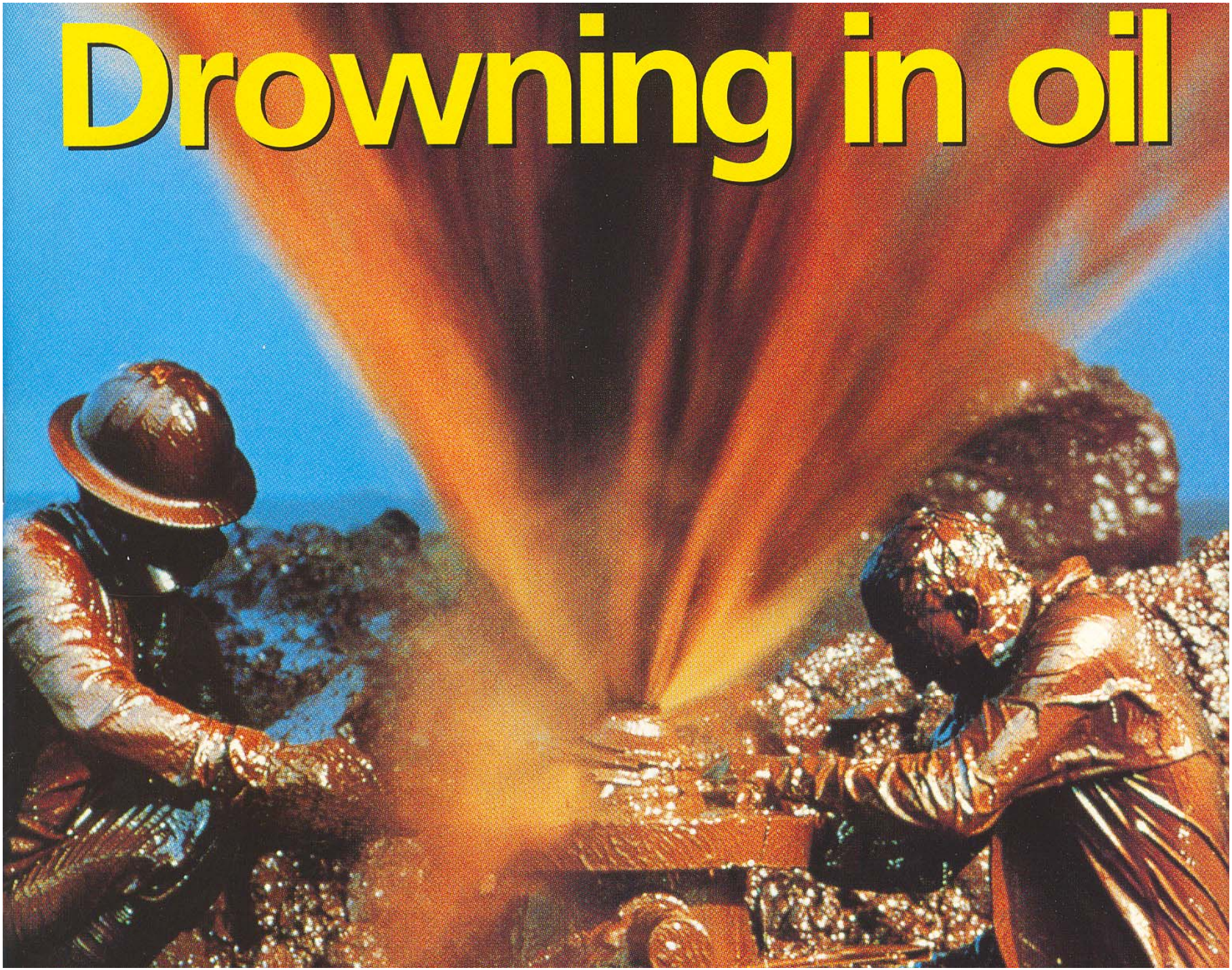
Is God Brazilian?

Sub-salt at Tupi

Single well costs $100 million; development will take decades

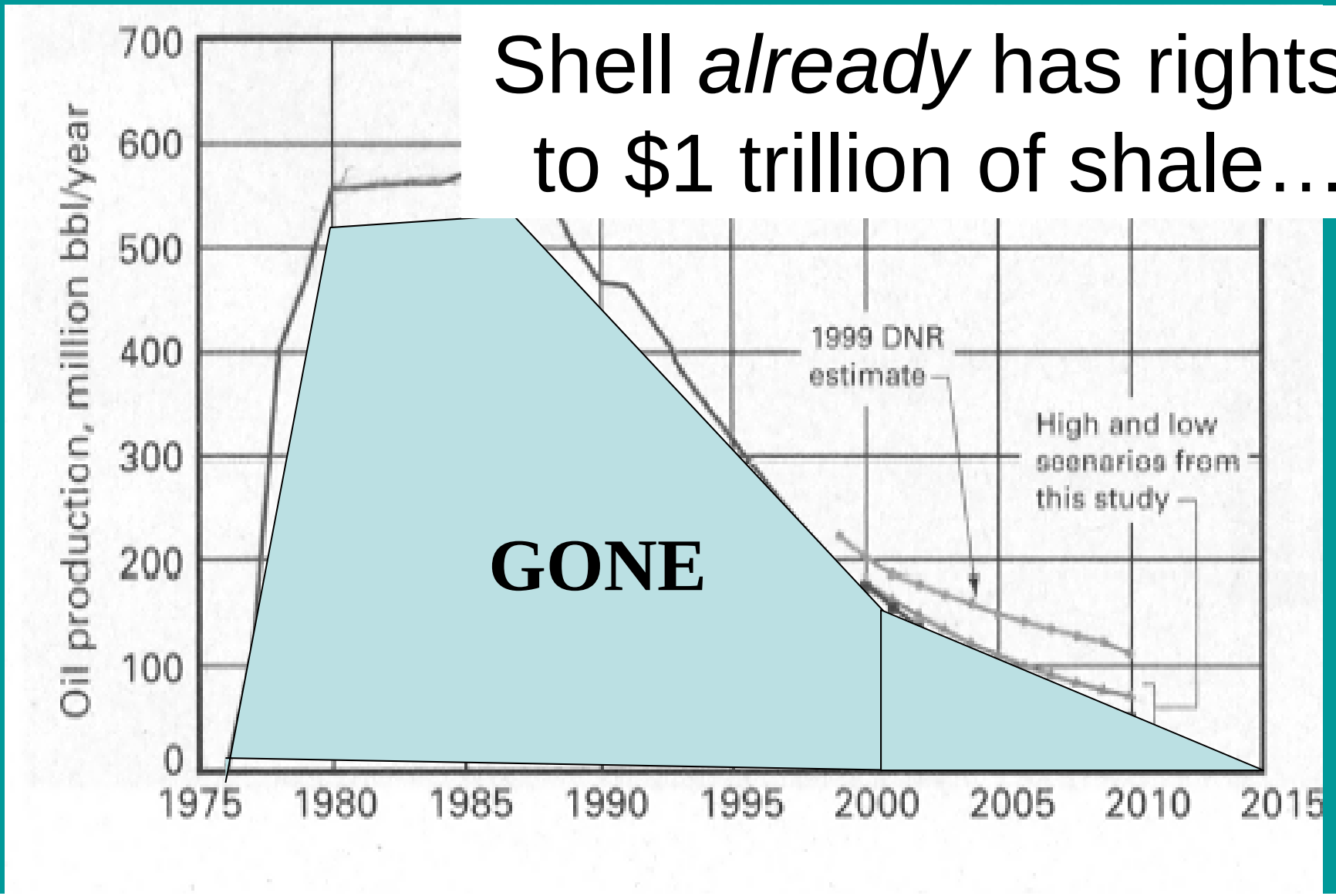
Petroleum Quality



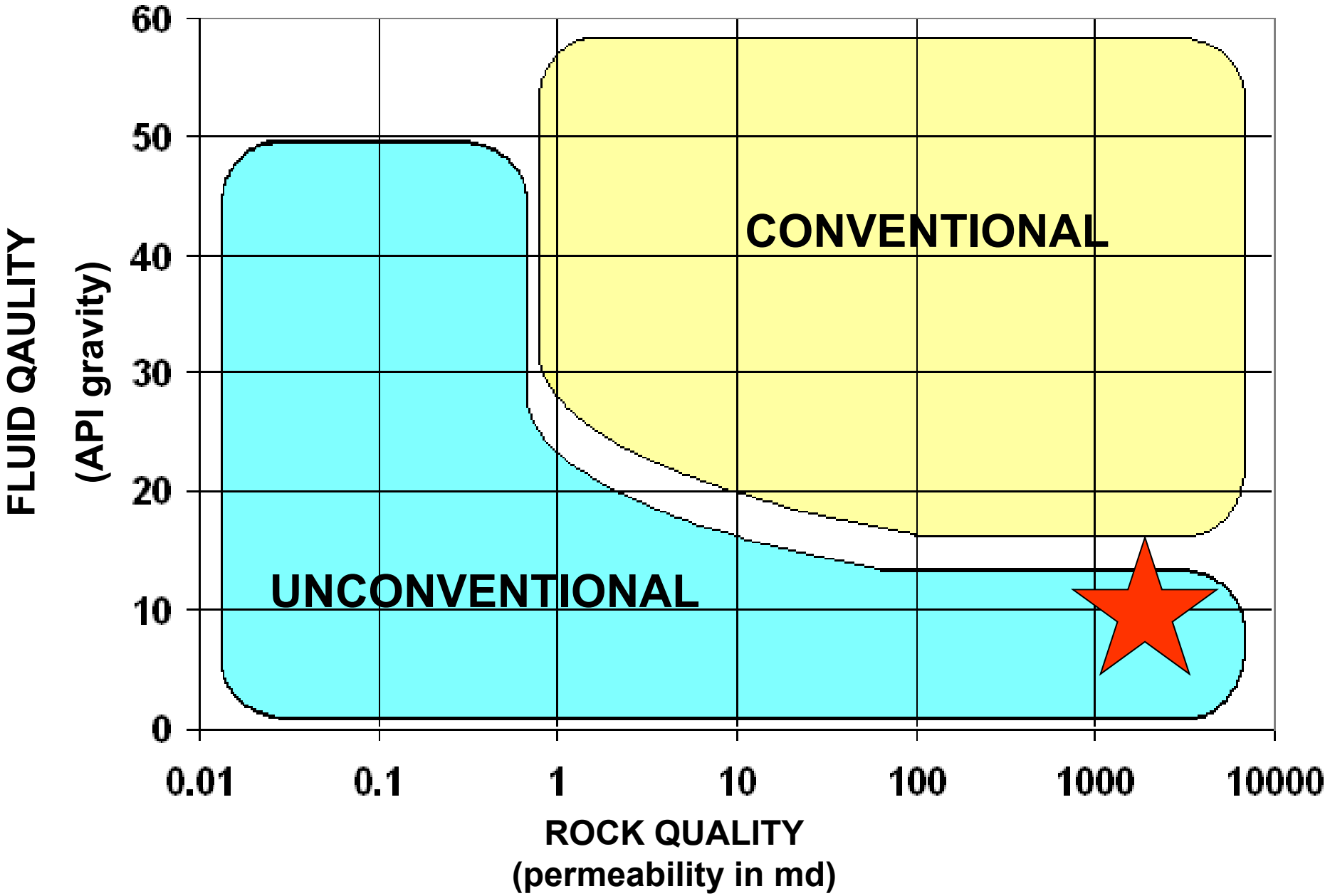

Drowning in oil


AMEL
PLEASURE
TO
BURN
JANE
GENERAL'S WARNING: Cigarette
ontains Carbon Monoxide.
SINCE 19

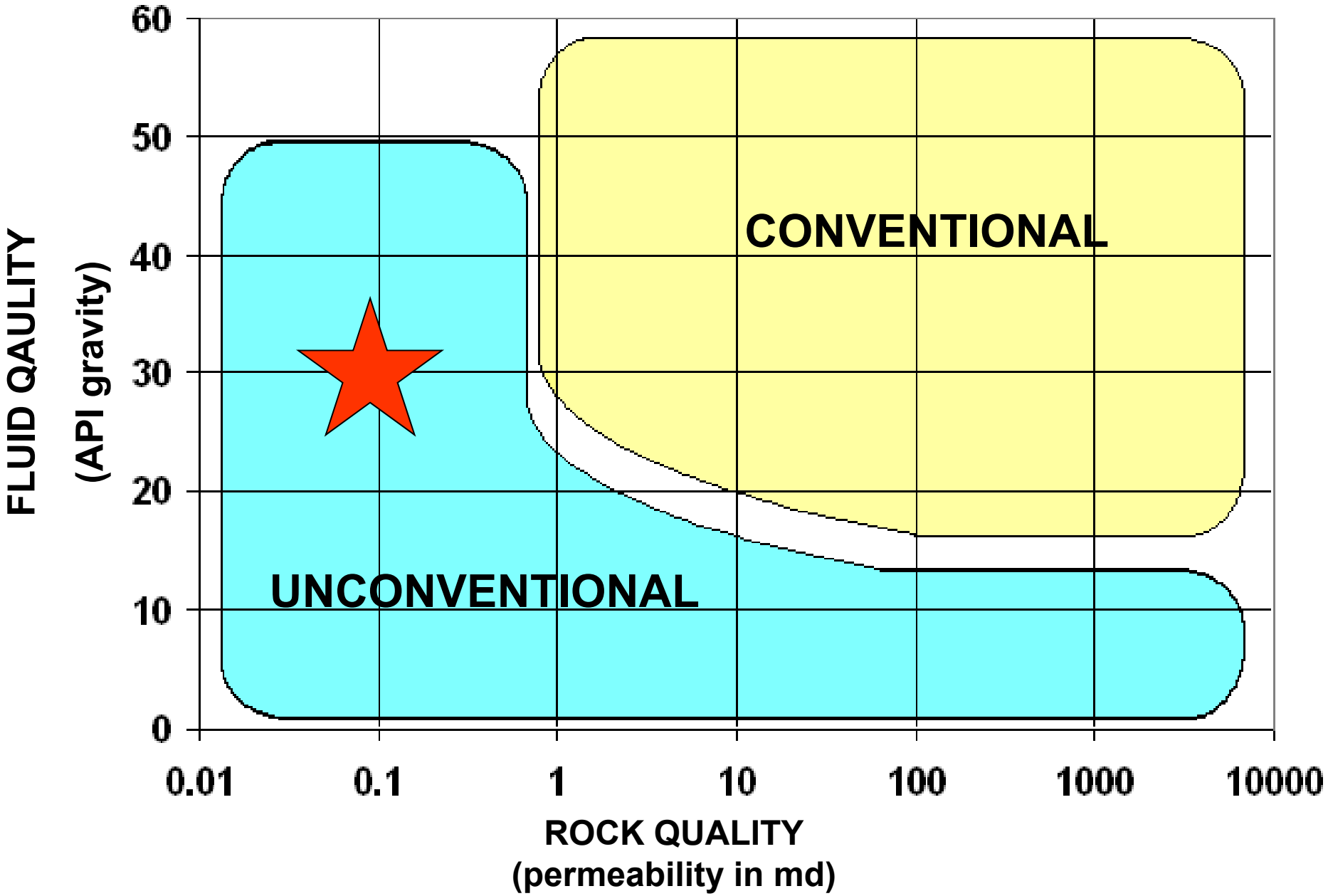
Prudhoe Bay: 15 billion barrels



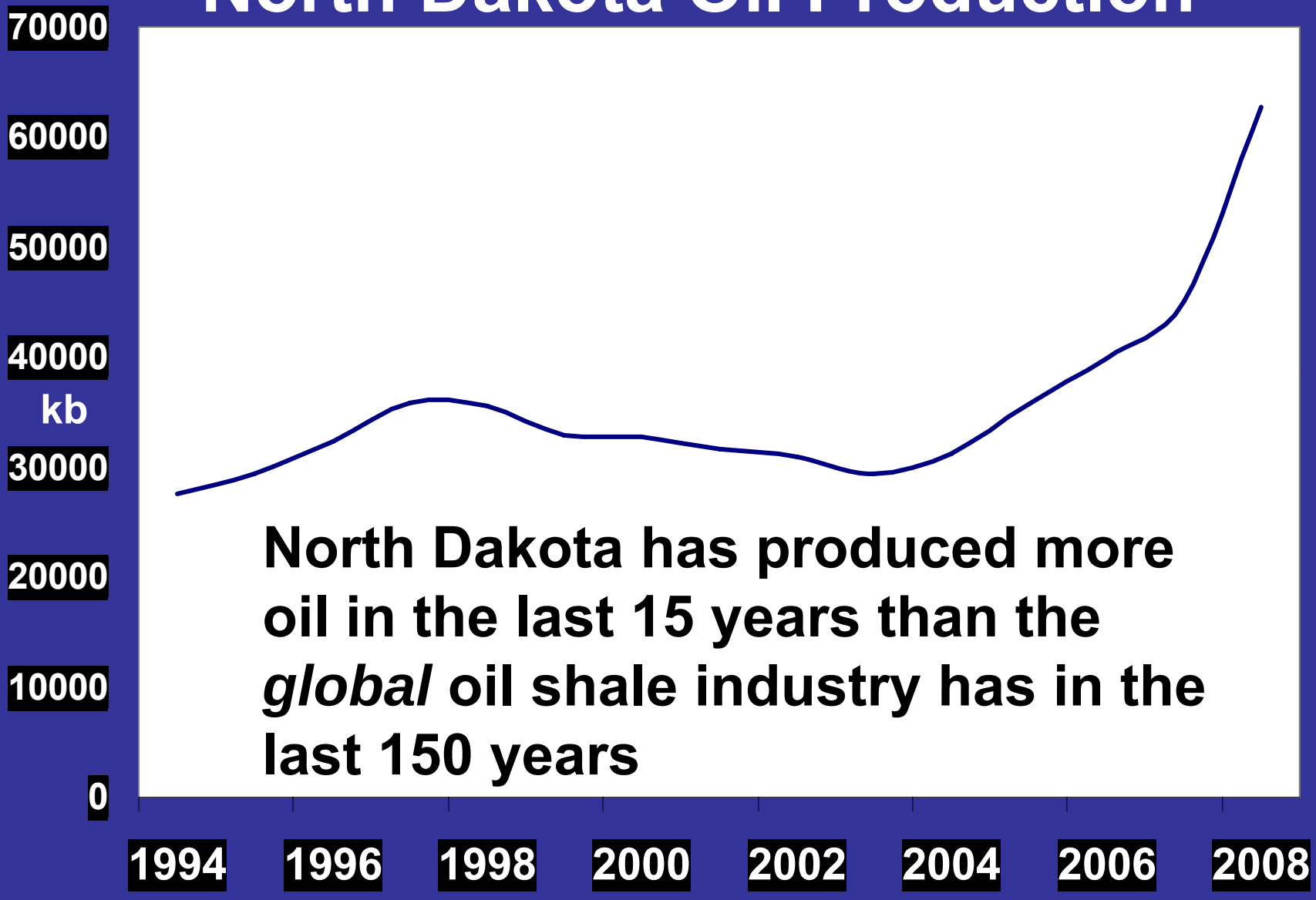
Petroleum Quality



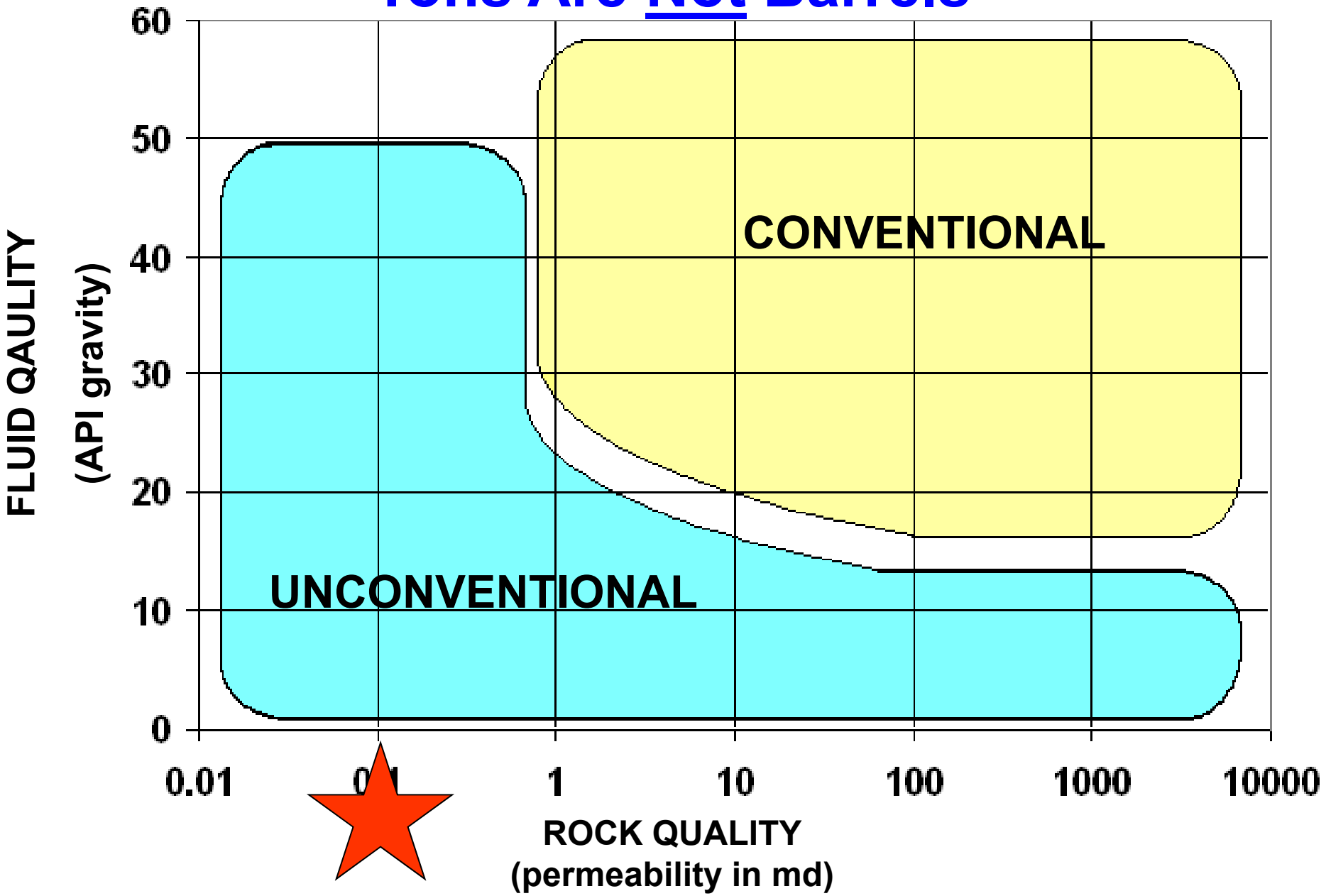
Petroleum Quality



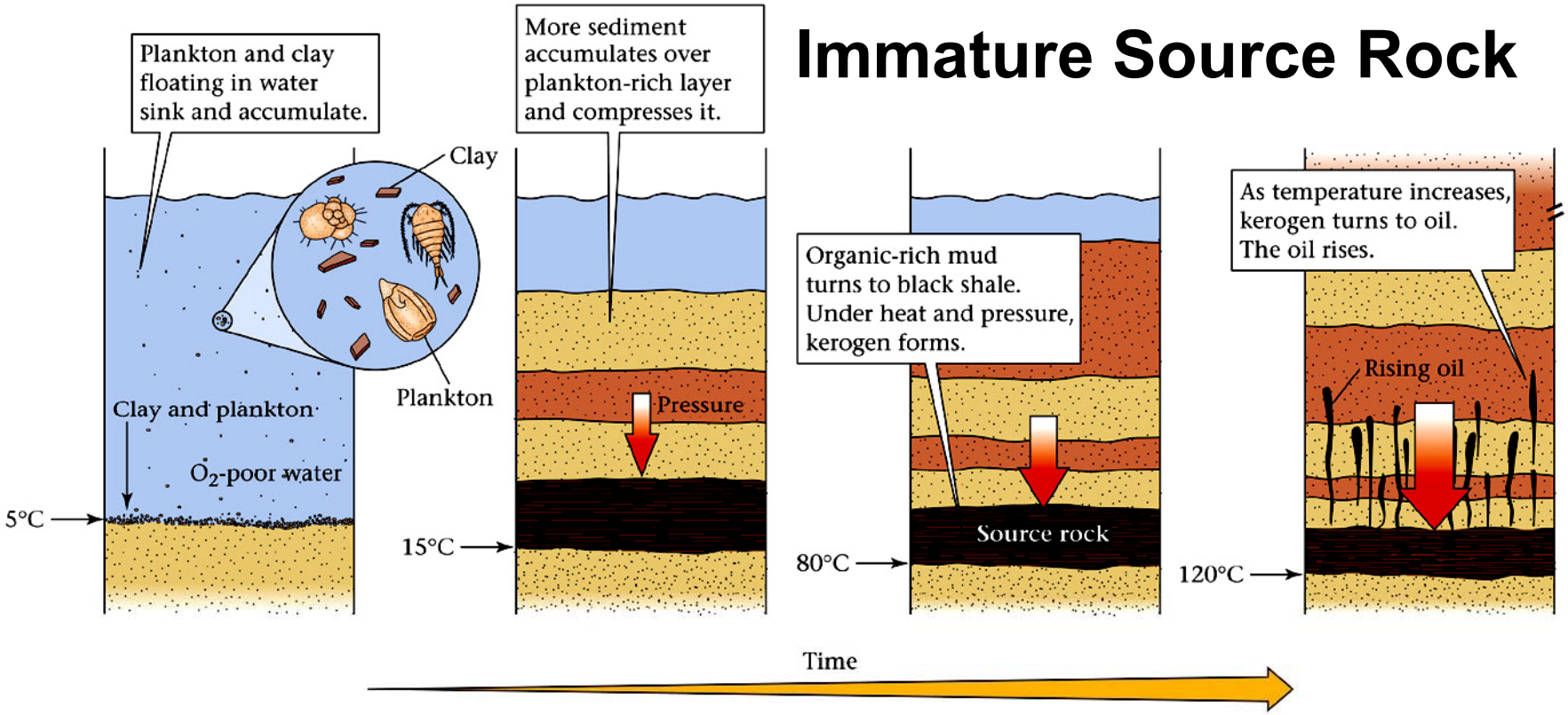
North Dakota Oil Production



Kerogen Is Not Petroleum, Tons Are Not Barrels



Immature Source Rock

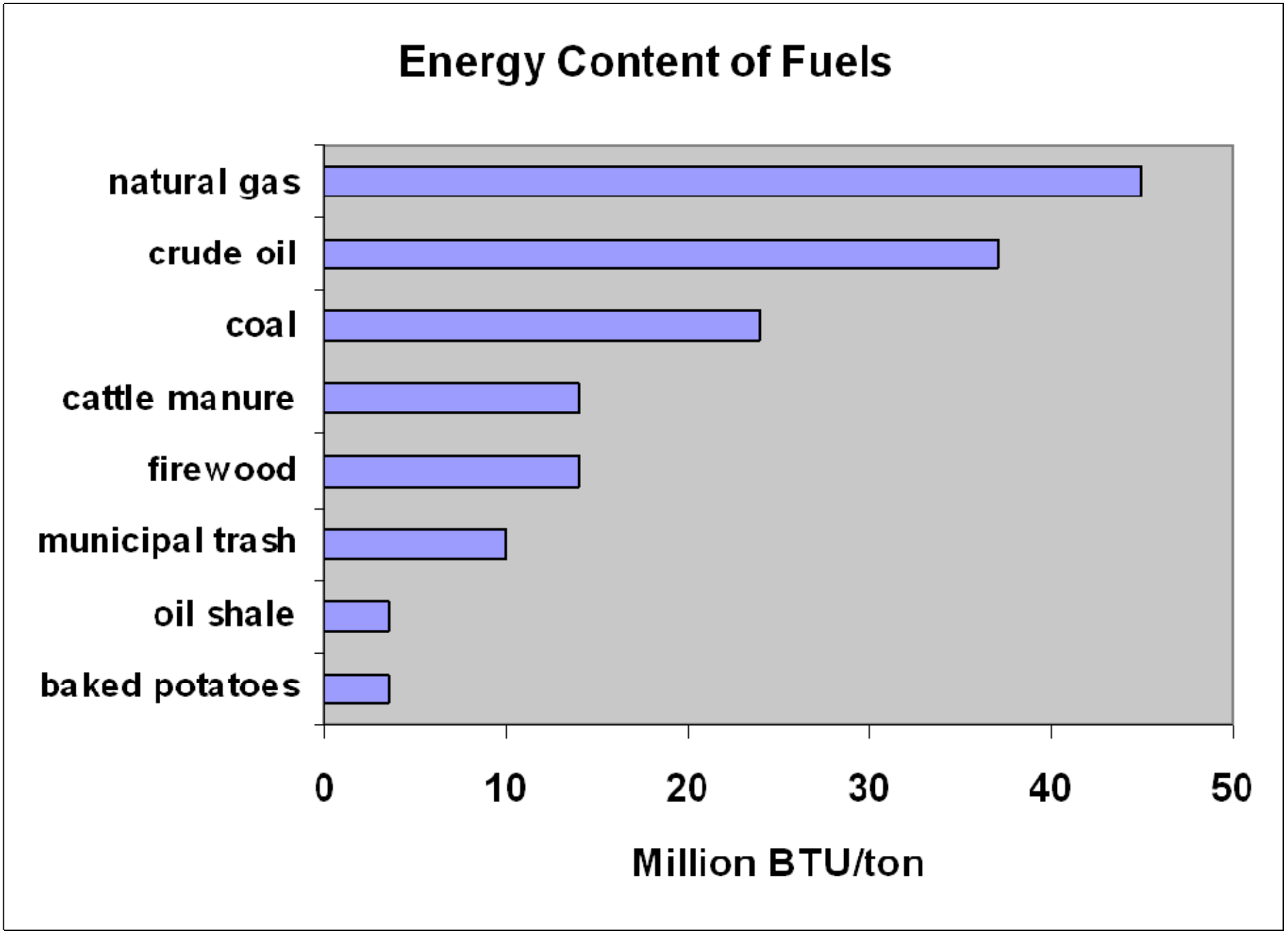


accumulation of organics and clay → burial - organic black shale → deeper burial - kerogen → oil generation & migration

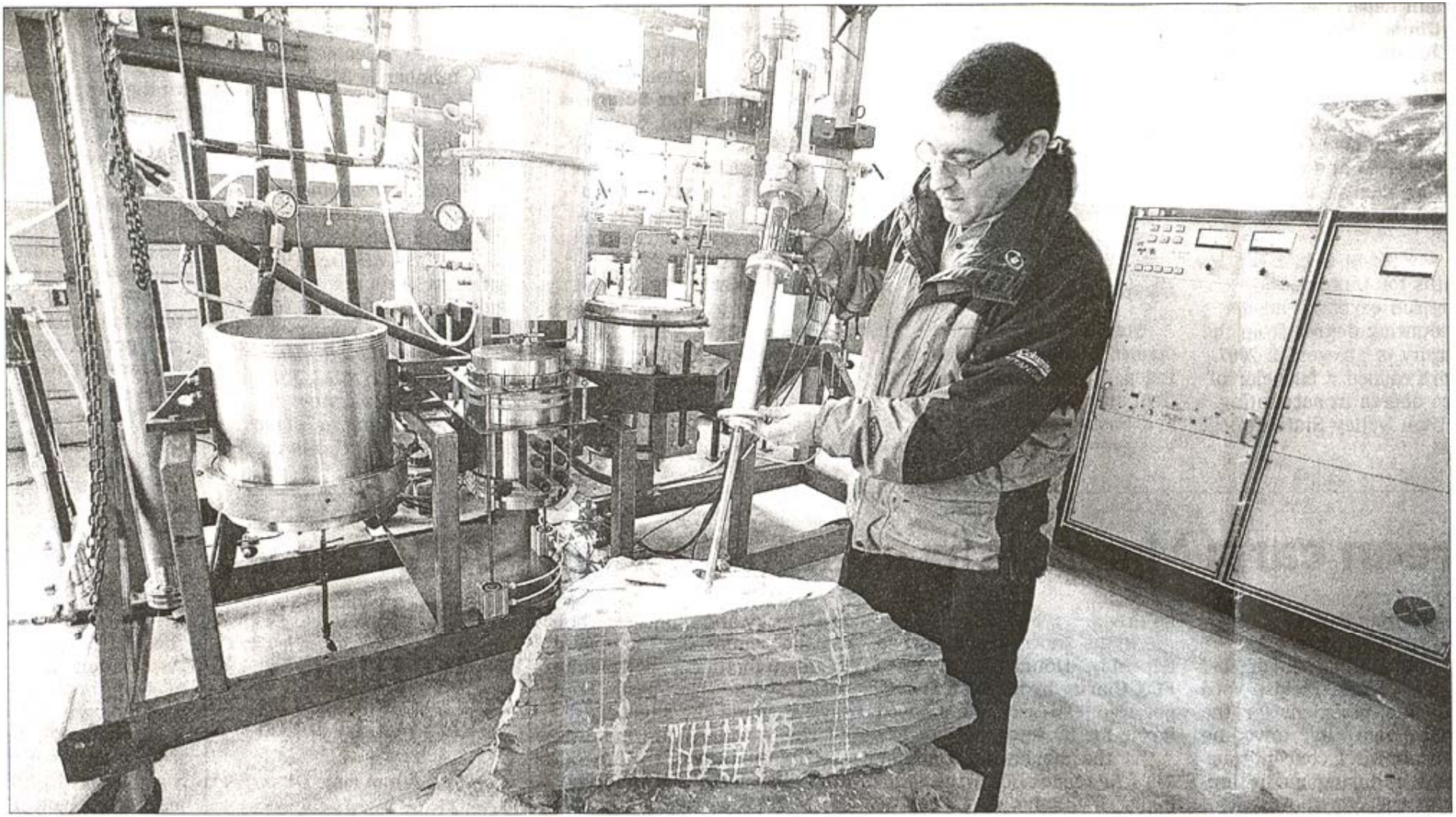
Wishing Can't Make it So

“In reality, so-called ‘oil shale’ is a low-grade, high-ash, hydrogen-rich, sapropelic coal”

--Utah Geology Prof


Energy Content of Fuels
natural gas
crude oil
coal
cattle manure
firewood
municipal trash
oil shale
baked potatoes
0
10
20
30
40
50
Million BTU/ton

Cap'n Crunch contains 3 times more energy per pound than oil shale



MICHAEL DWYER/*The Associated Press*

Raytheon senior principal systems engineer *John Cogliandro pulls an RF antenna from a shale sample at CF Technologies in Boston. The antenna transmits radio frequencies that generate heat to melt a waxy substance in the shale called kerogen so that it can be converted into oil.*

Zap and extract: Shale yields oil

Week of July 10, 2006/US$10.00

OIL&GAS JOURNAL®

Nuclear energy proposed for production of shale oil

Judy R. Clark
Senior Associate Editor

Nuclear energy is being proposed as an alternative to gas-powered electricity as a heat source for in situ shale oil recovery in the US.

Nuclear engineer Charles W. Forsberg of the US Department of Energy's Oak Ridge National Laboratory, Oak Ridge, Tenn., described the proposal at the American Nuclear Society's 2006 International Congress on Advances in Nuclear Power Plants in Reno, Nev., June 7.

He said nuclear heat could be used to extract the vast US oil shale deposits more economically and in a much more environmentally benign manner than traditional oil shale recovery methods. Forsberg is senior scientist and senior reactor technical advisor for the lab's Nuclear Science and Technol-

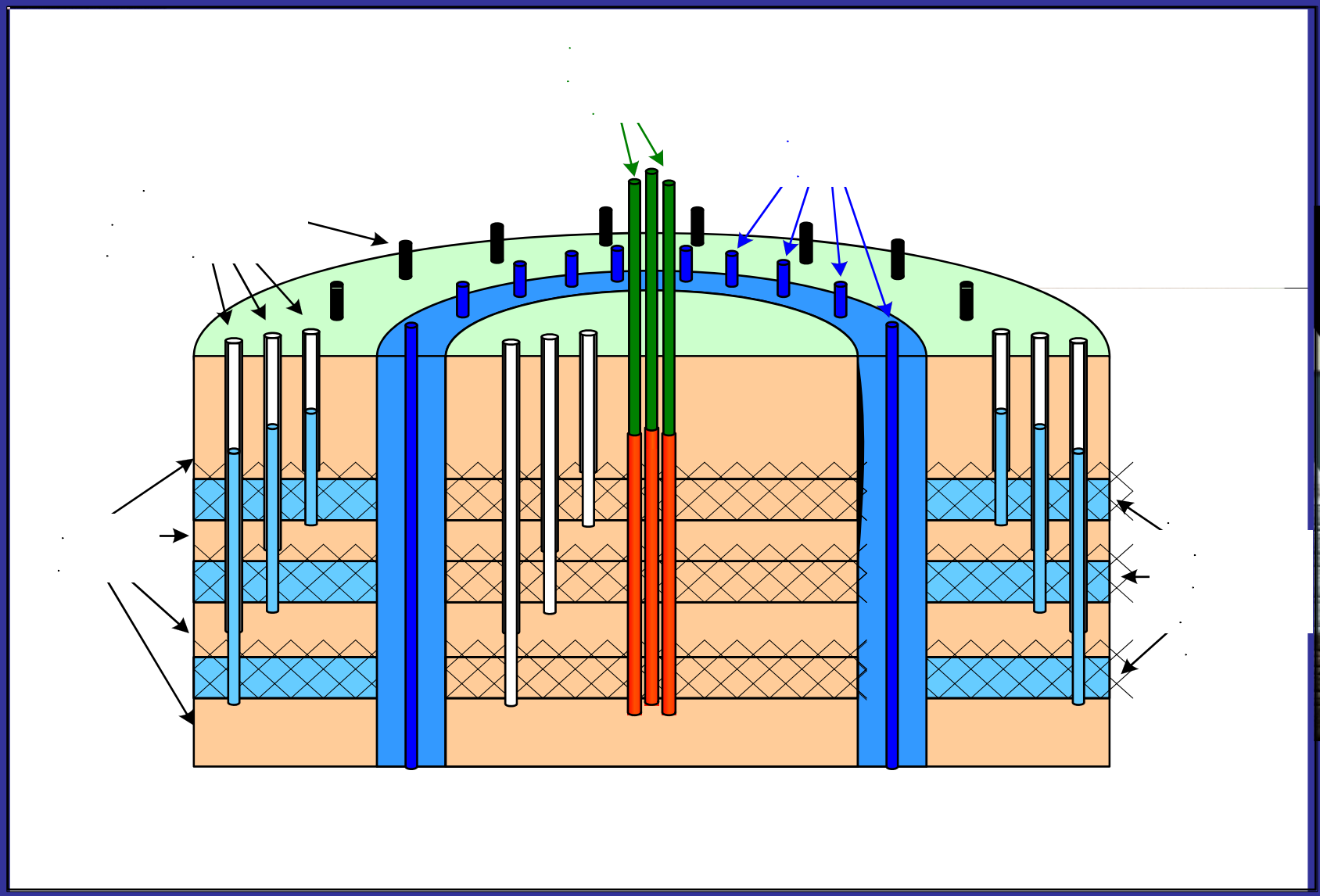
half that required for traditio
recovery processes, Forsberg
ever, the company is still add
major technical challenges, h

The alternative to electric
to recover oil from shale usi
heat provided by a nuclear r
This would release lower vo
greenhouse gases, particular
dioxide, and cost less than t
situ methods.

The US has 500 billion-1
bbl of potentially recoverabl
in the Green River, Washaki
and Piceance Creek basins i
Utah, and Wyoming, Forsbe

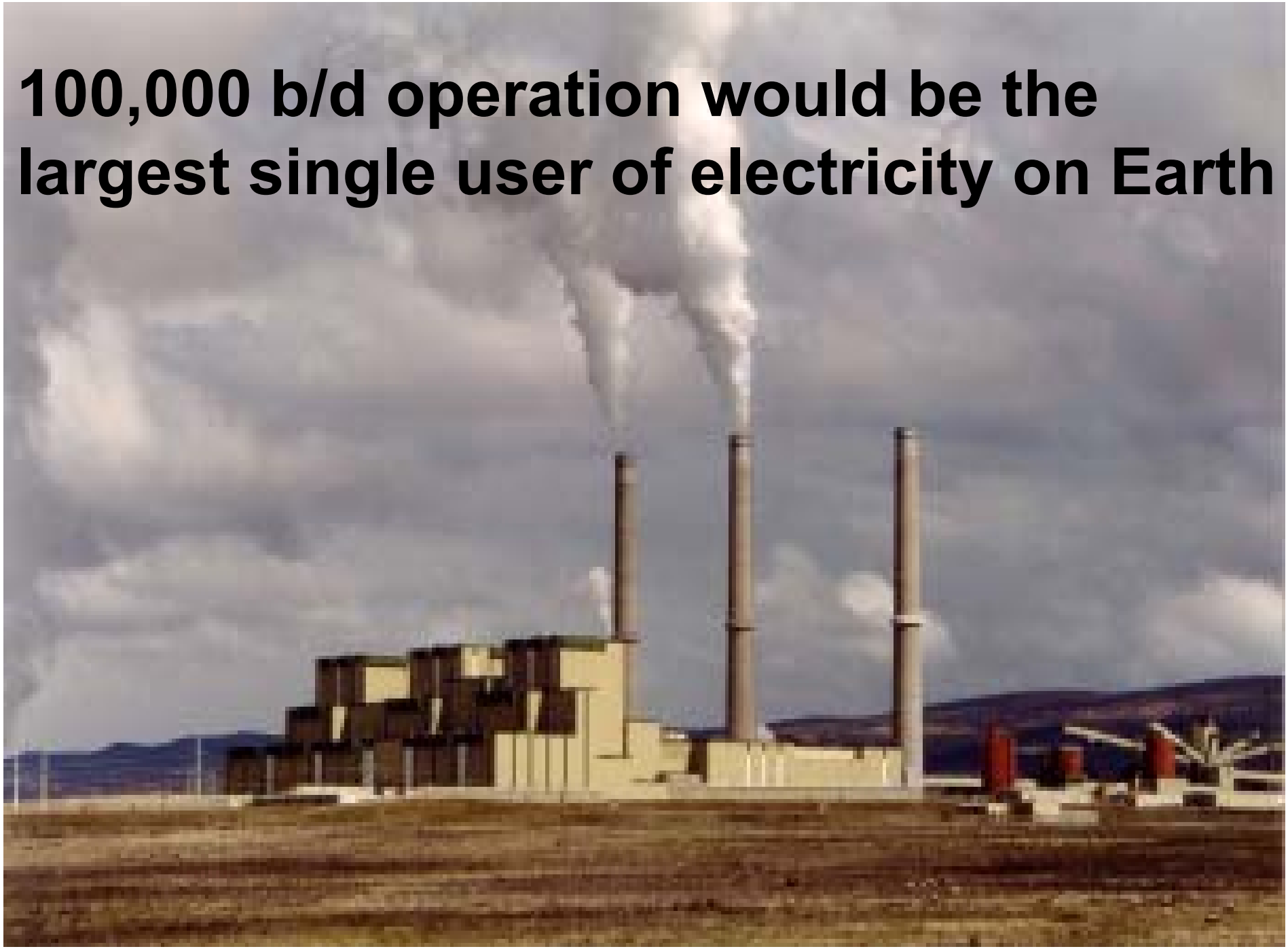
Because most US oil shale
more than 500 ft thick—wit
than 2,000 ft thick—some a
basins can yield more than 2
bbl/acre of oil, he said, and
its contain 25-50 gal/ton of

hell's "\ube oldberg"



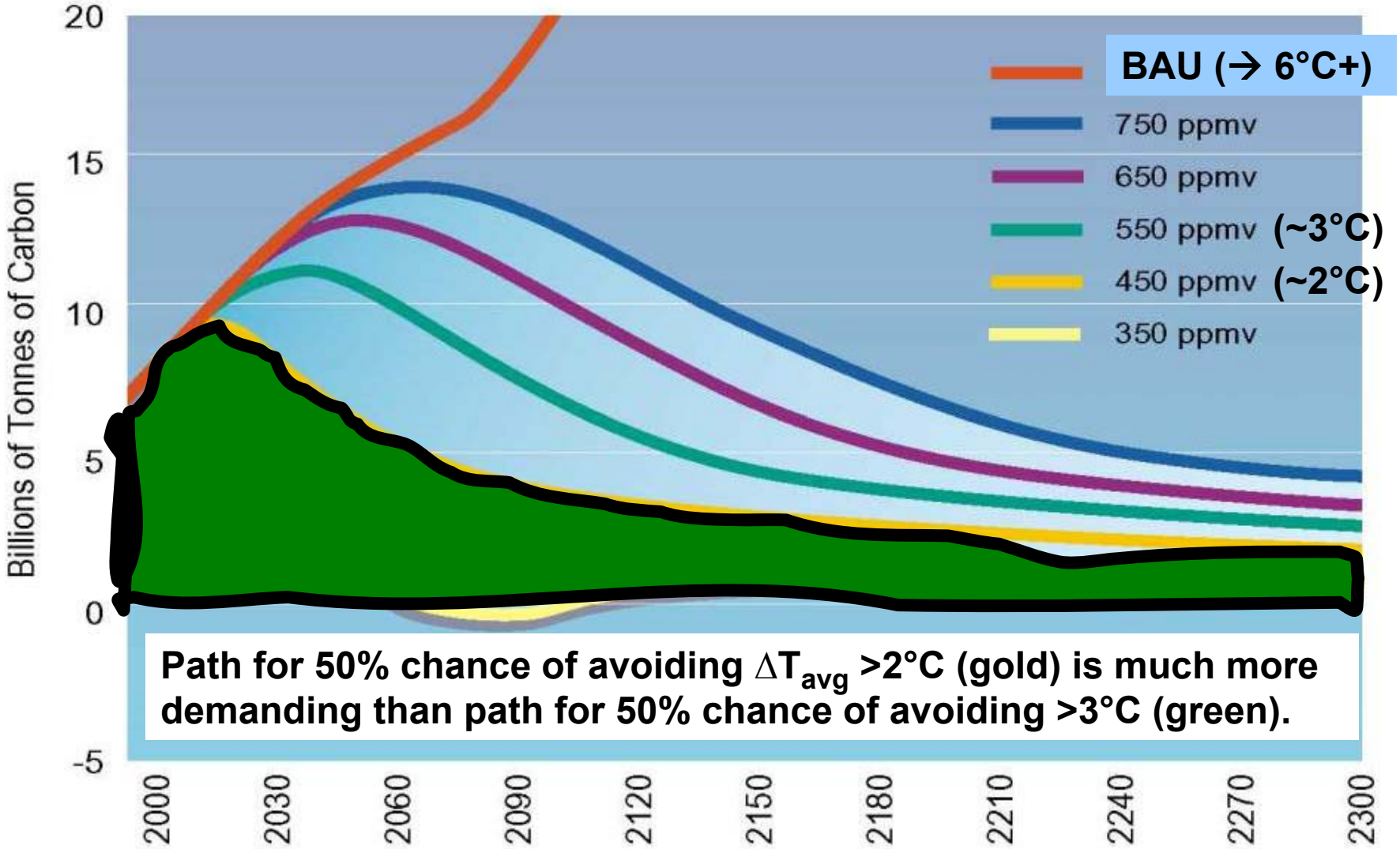

Energy Return Will be Very Low

100,000 b/d operation would be the largest single user of electricity on Earth




Climate change starts here
CLIMATE RESCUE
GREENPEACE

‘Carbon Budget’ must be divided between nations, generations, and *fuels*

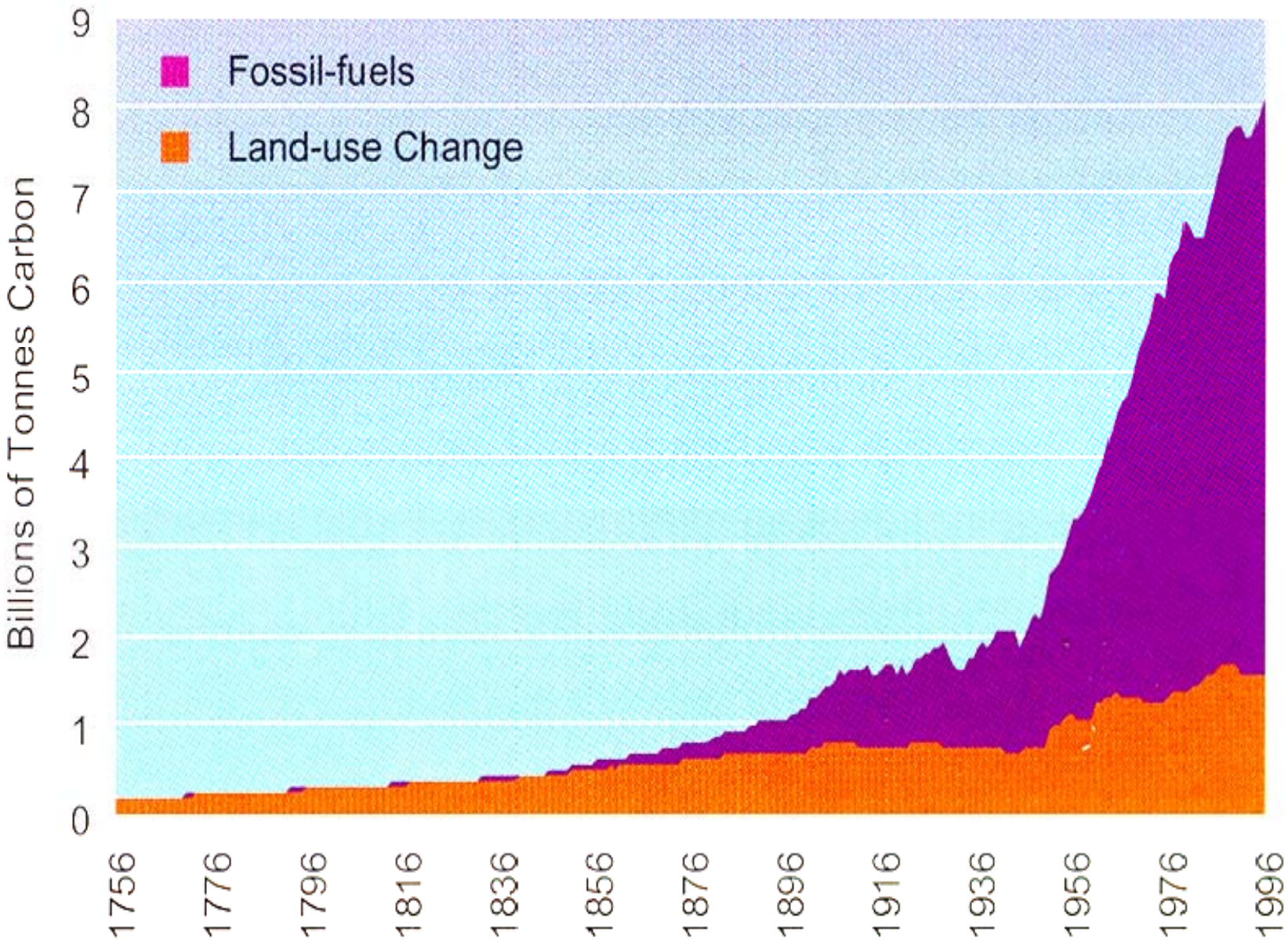


The Ultimate IQ test

Other energy alternatives make much more sense


FAIL

Global Carbon Emissions

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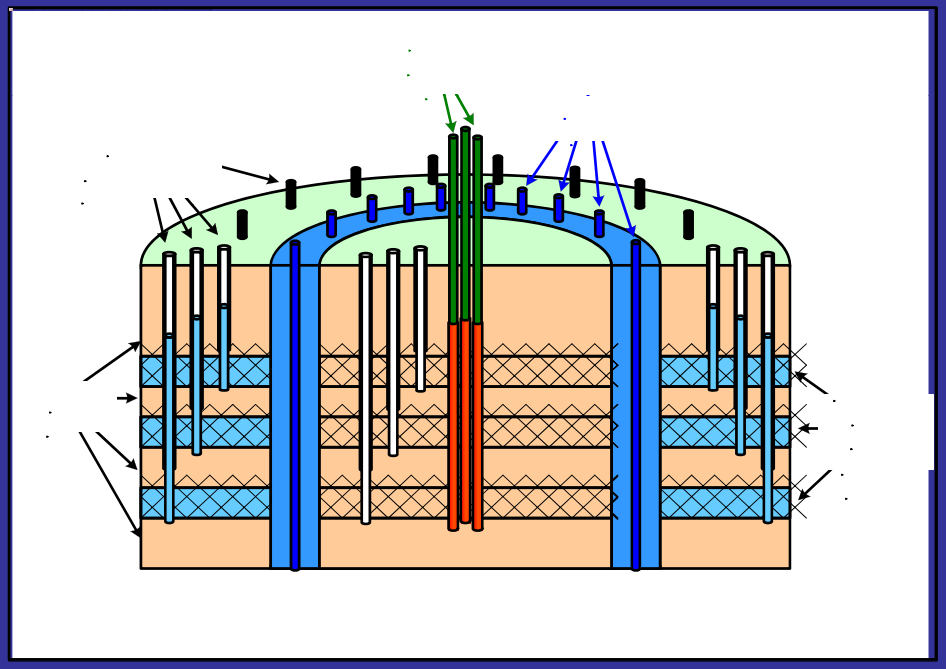
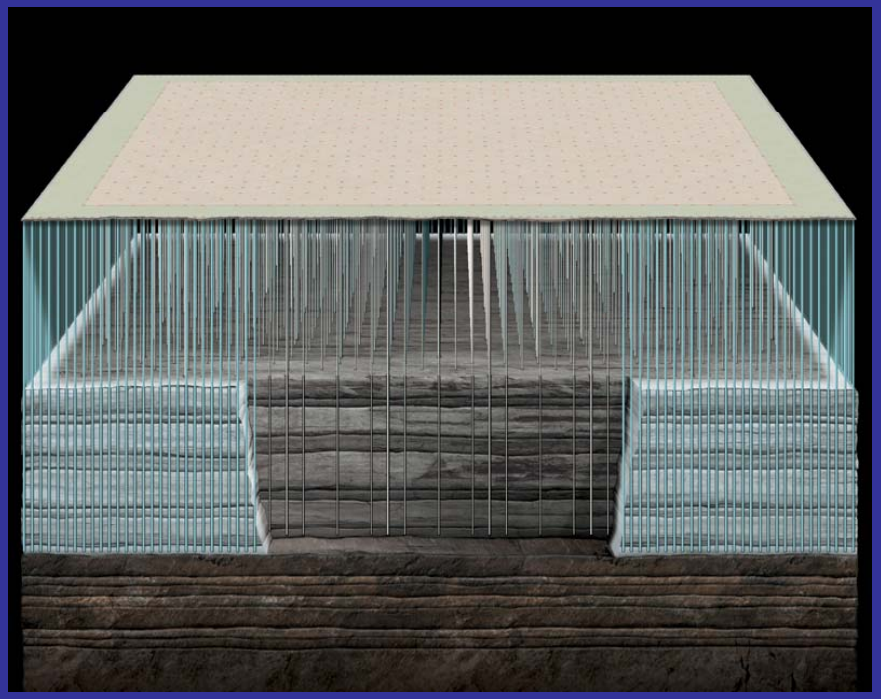
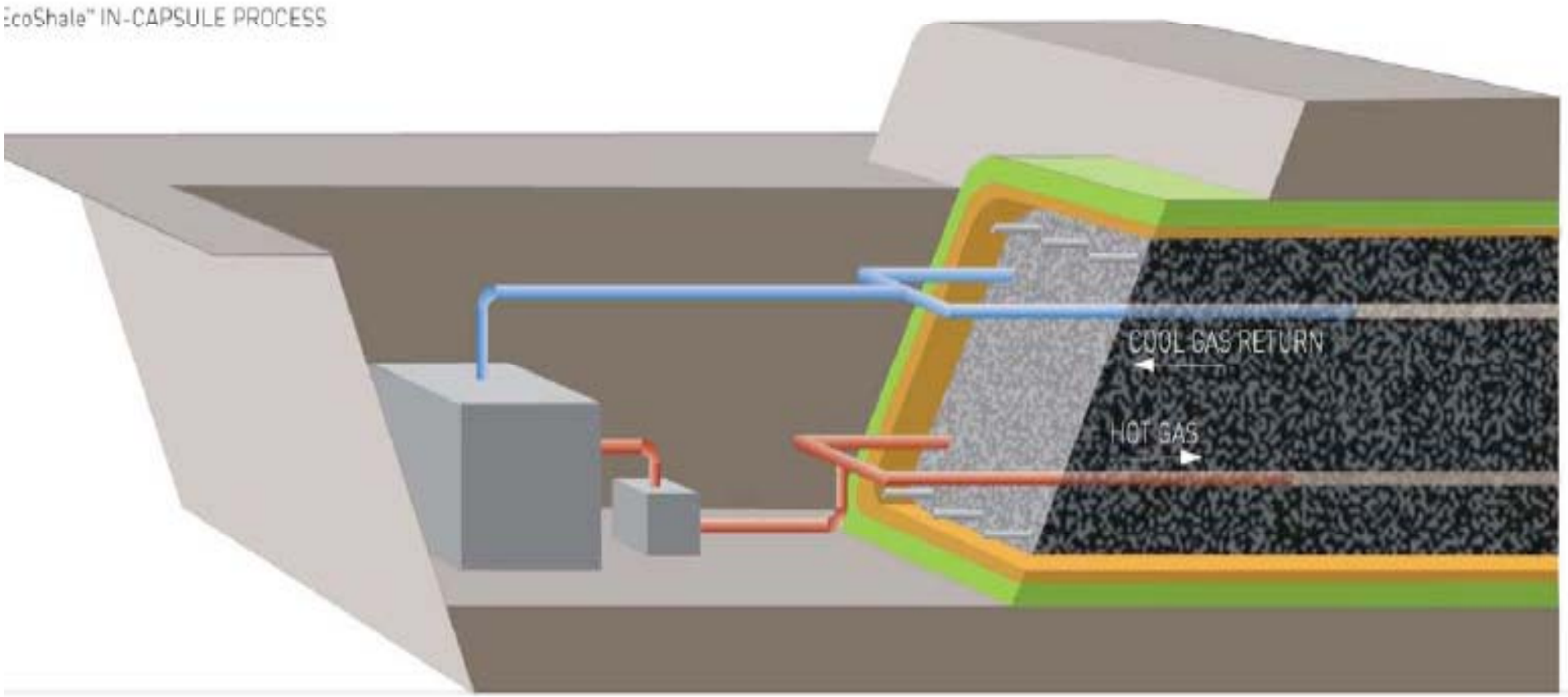
hell’s



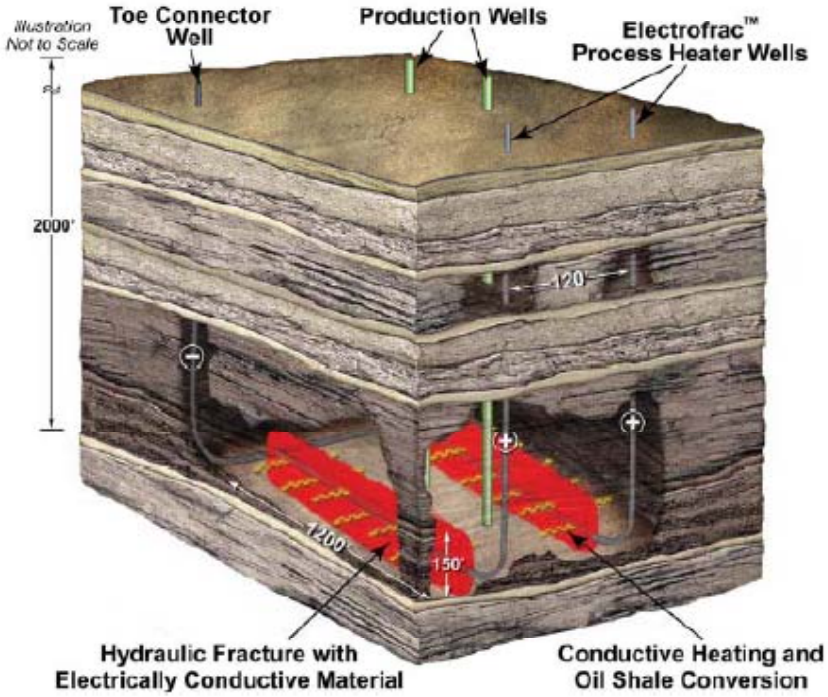


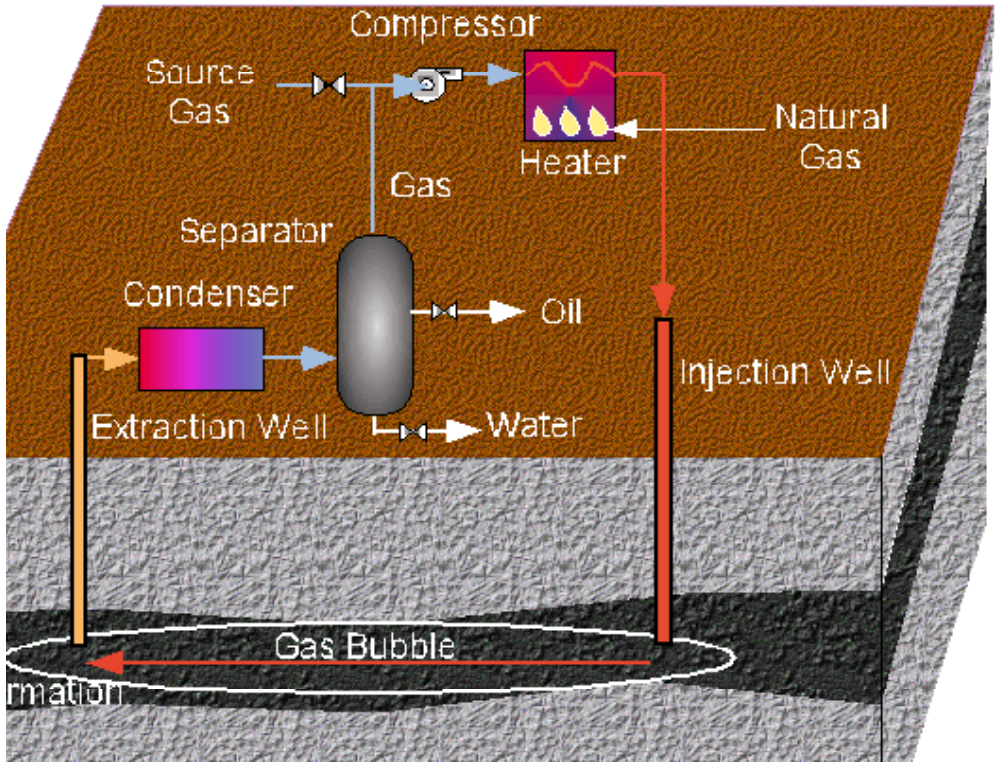
Red Leaf Resources Ecoshale™ Process

- Very low water use
- High Energy Return on Investment
- Pilot test completed



- Create electrically conductive fractures (vertical or horizontal)
- Planar heat source more effective than radial conduction from wellbore
- Typical simulation
  - 150 foot fracture height
  - 5-year heating converts 325 feet of oil shale
  - 120-ft fracture spacing,
  - 74% heating efficiency

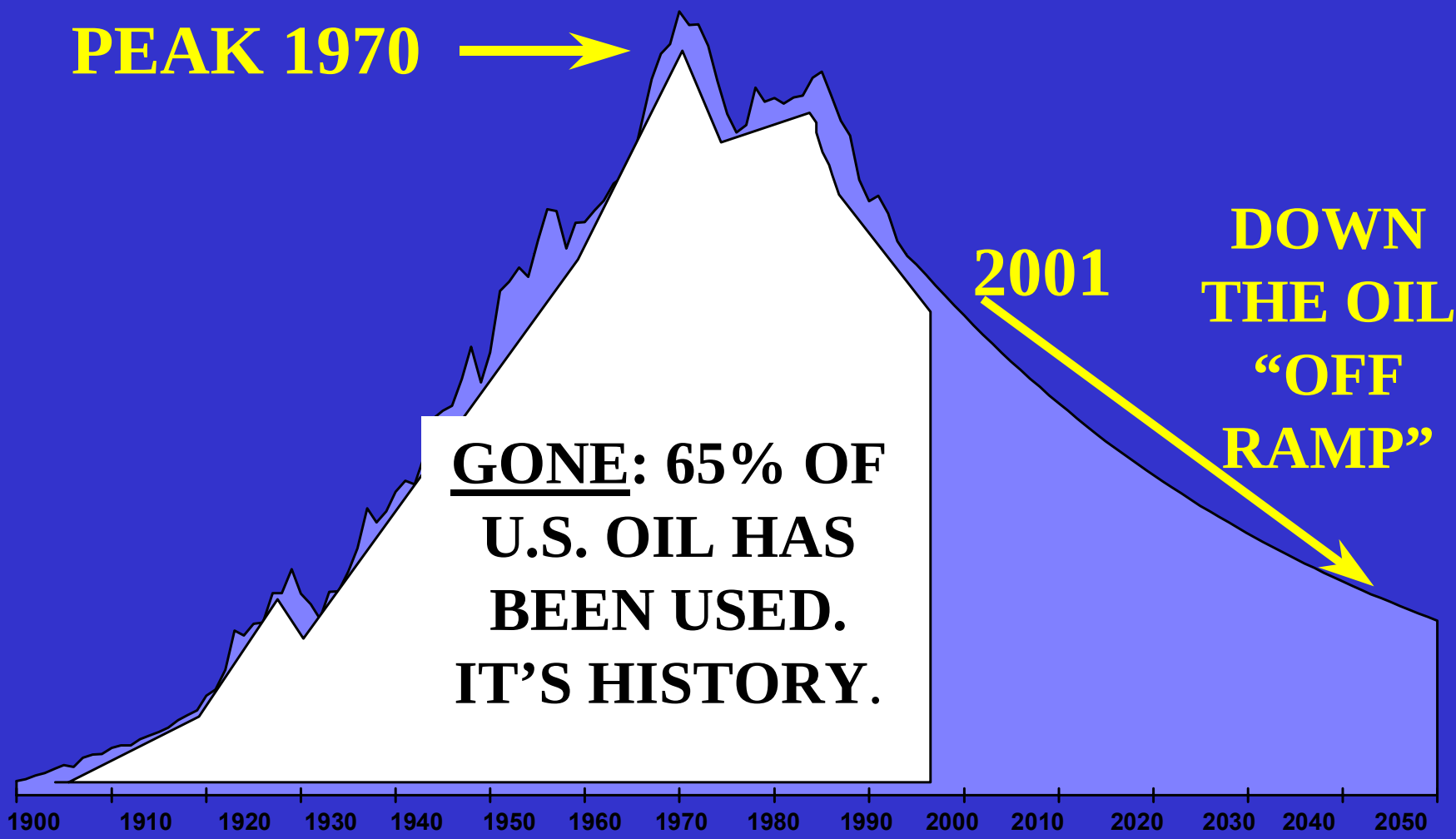


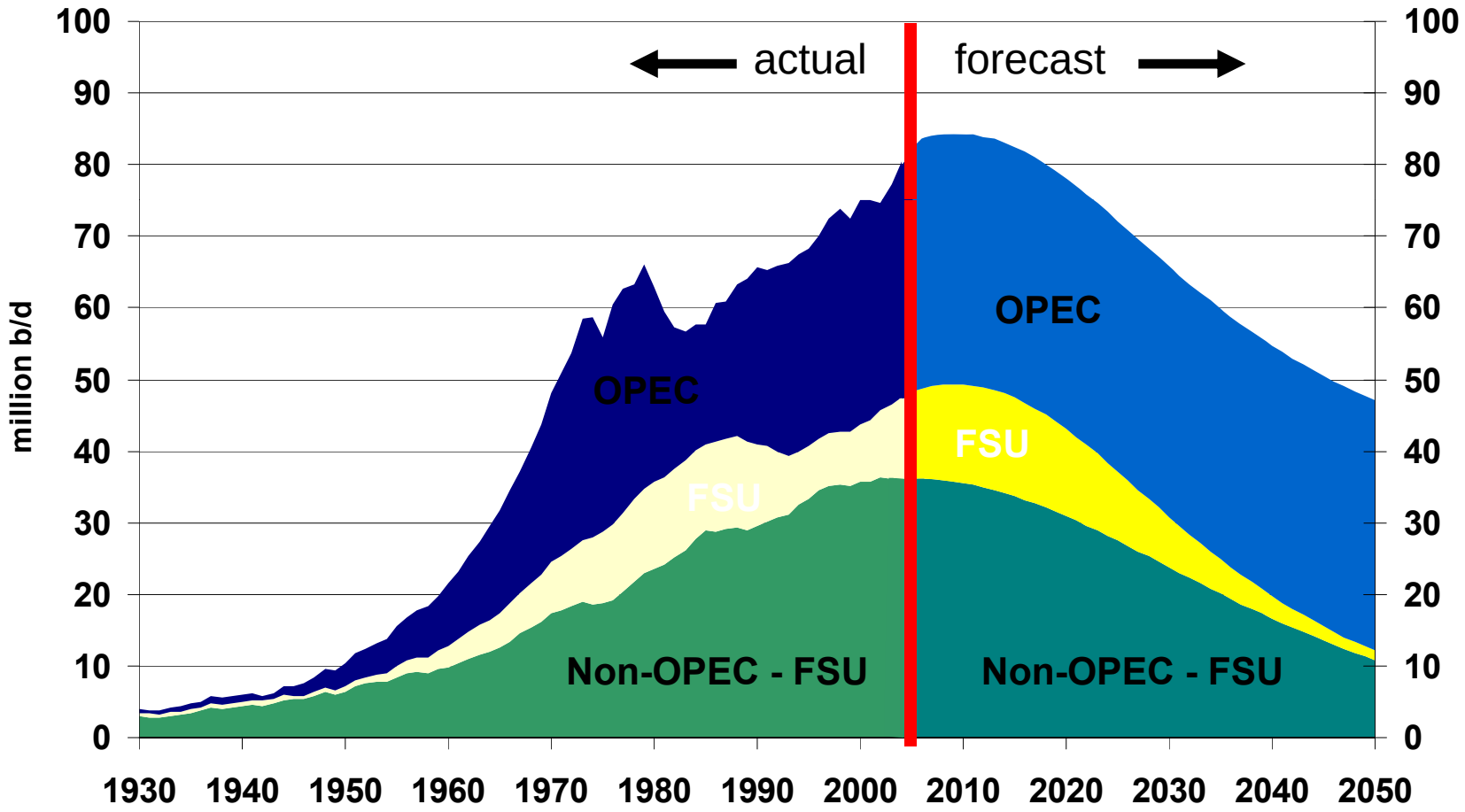

Compressor
Source Gas
Natural Gas
Heater
Gas
Separator
Condenser
Oil
Injection Well
Extraction Well
Water
Gas Bubble
rmation


400
300
¼ LITRE
200
100

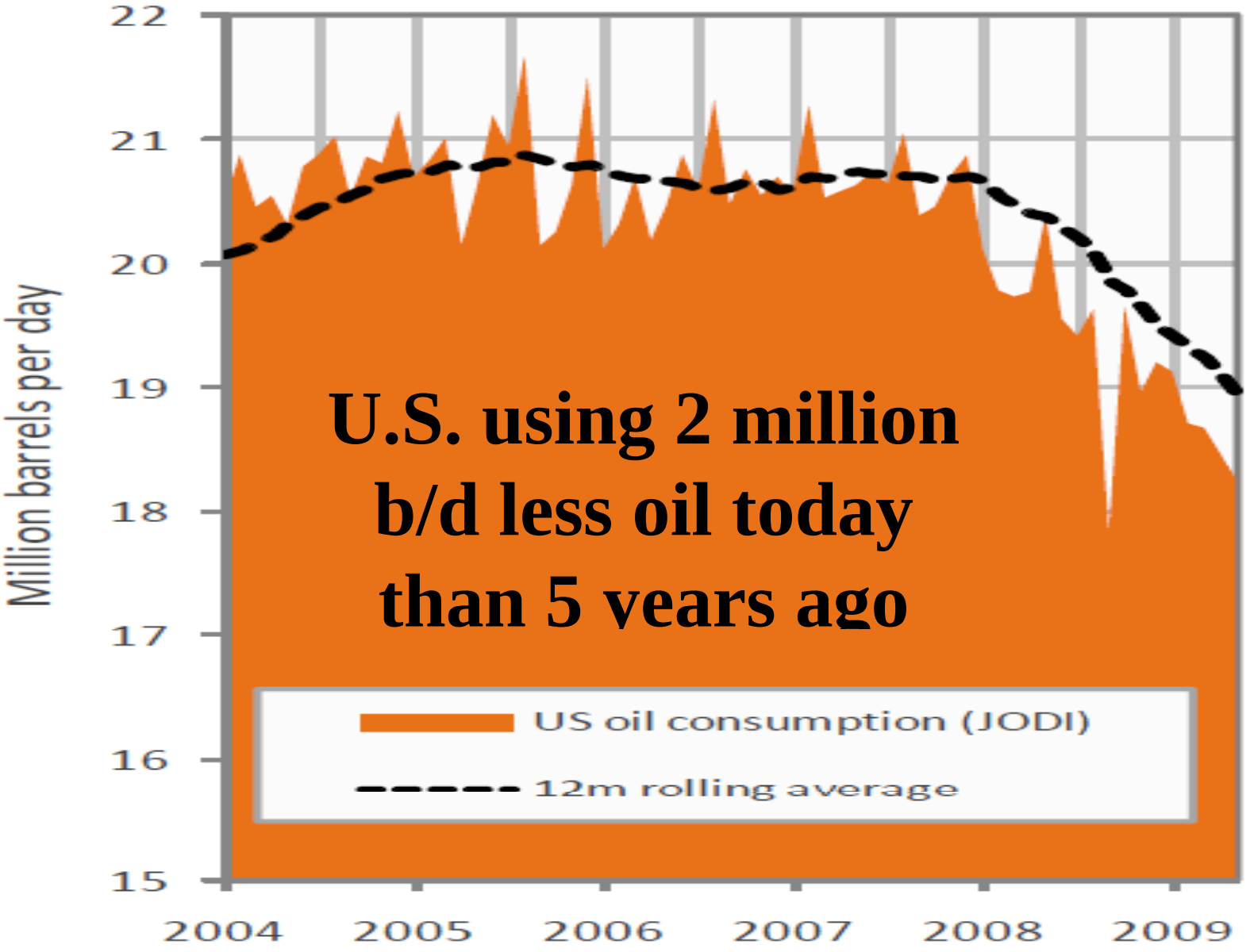

Home
Delivery
Rock
That Burns
ST PAUL, MN
USDOT 380932
Peterbilt

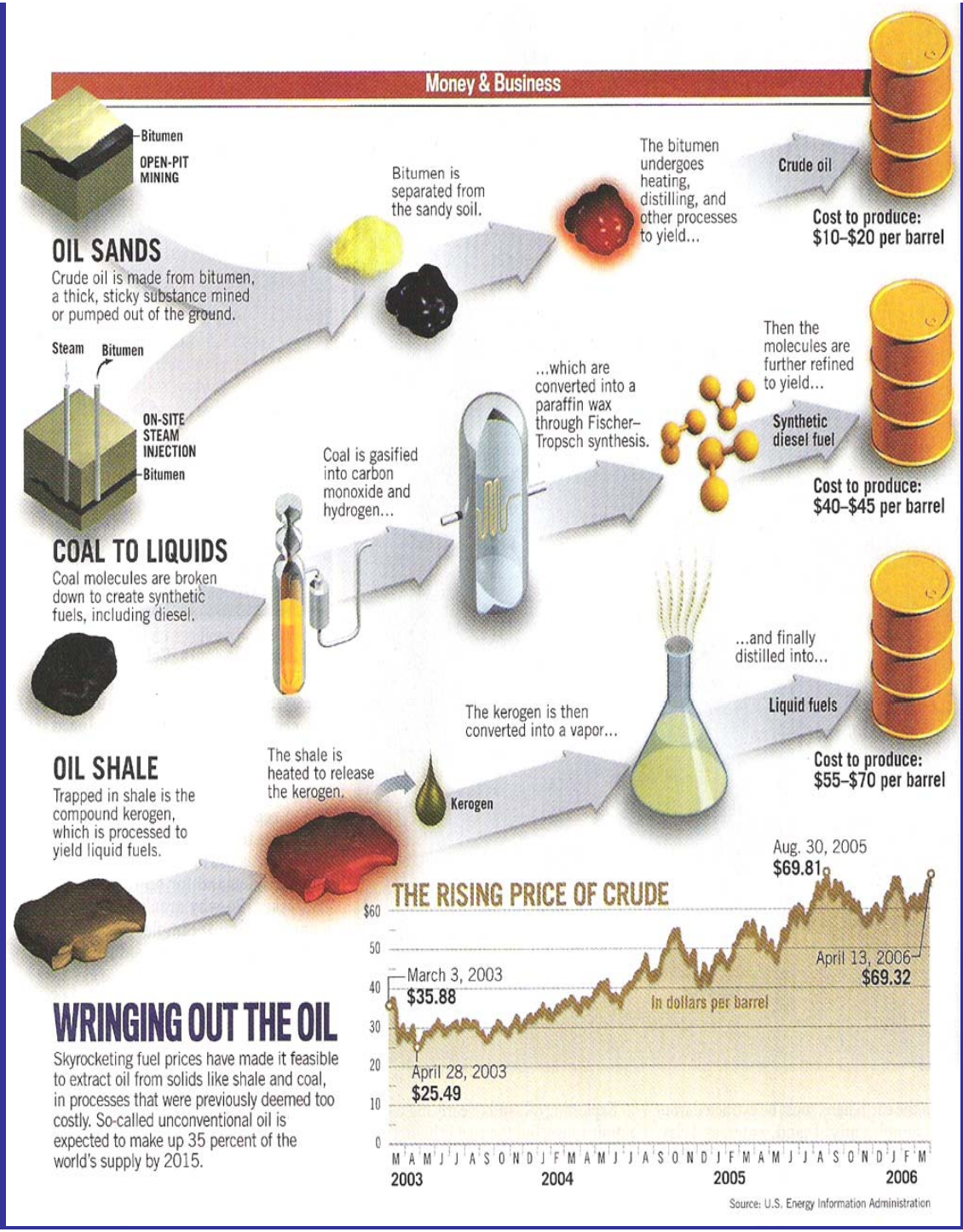
U.S. OIL PRODUCTION 1900 TO 2050




actual
forecast
million b/d
100
90
80
70
60
50
40
30
20
10
0
OPEC
FSU
Non-OPEC - FSU
OPEC
FSU
Non-OPEC - FSU
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050

We have *already* begun an energy transition





Remaining Oil

Conventional: 1000 Bb

Tar Sands: 500 billion

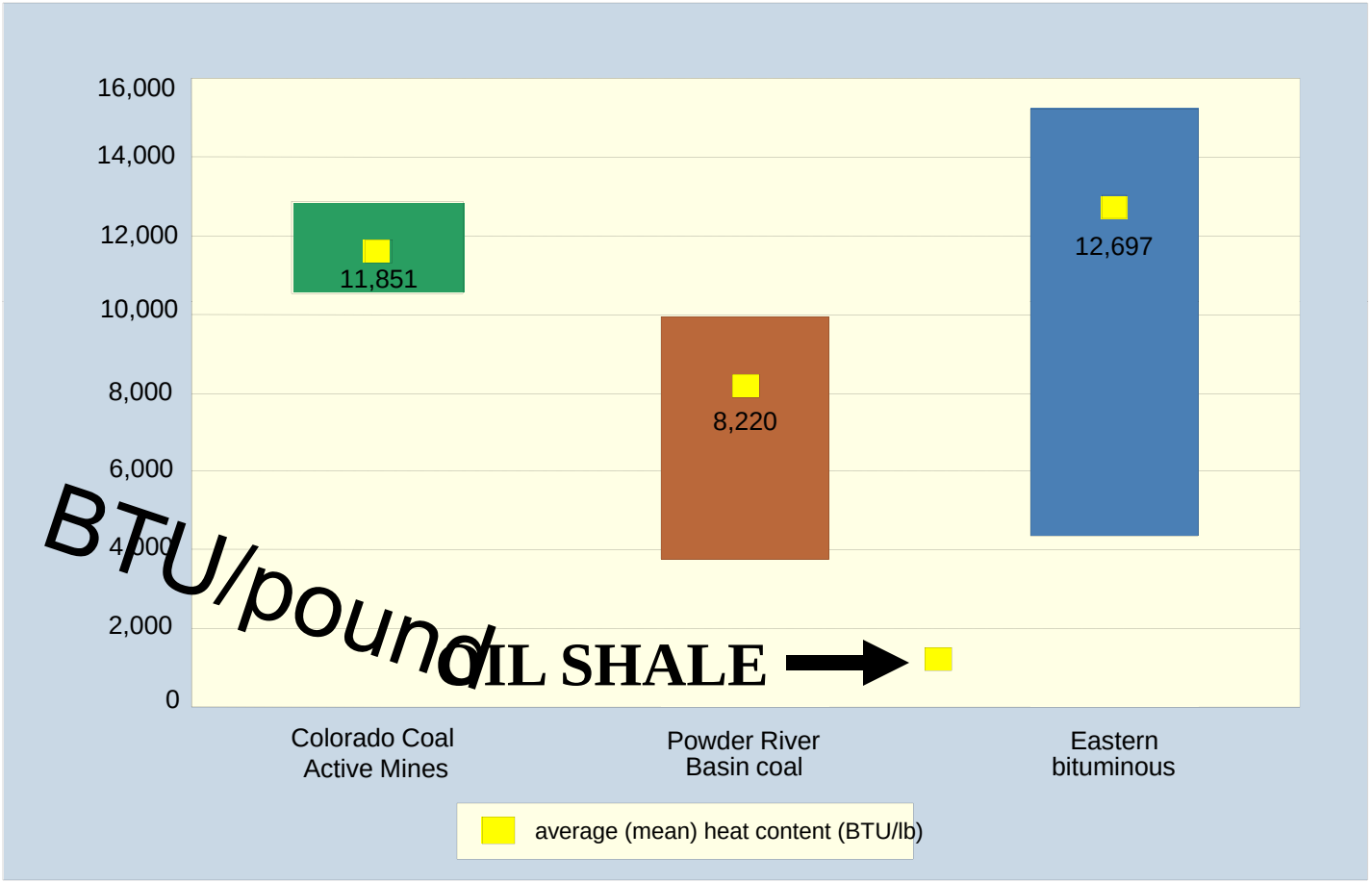
Bitumen: 500 billion

Oil Shale: 1000 billion

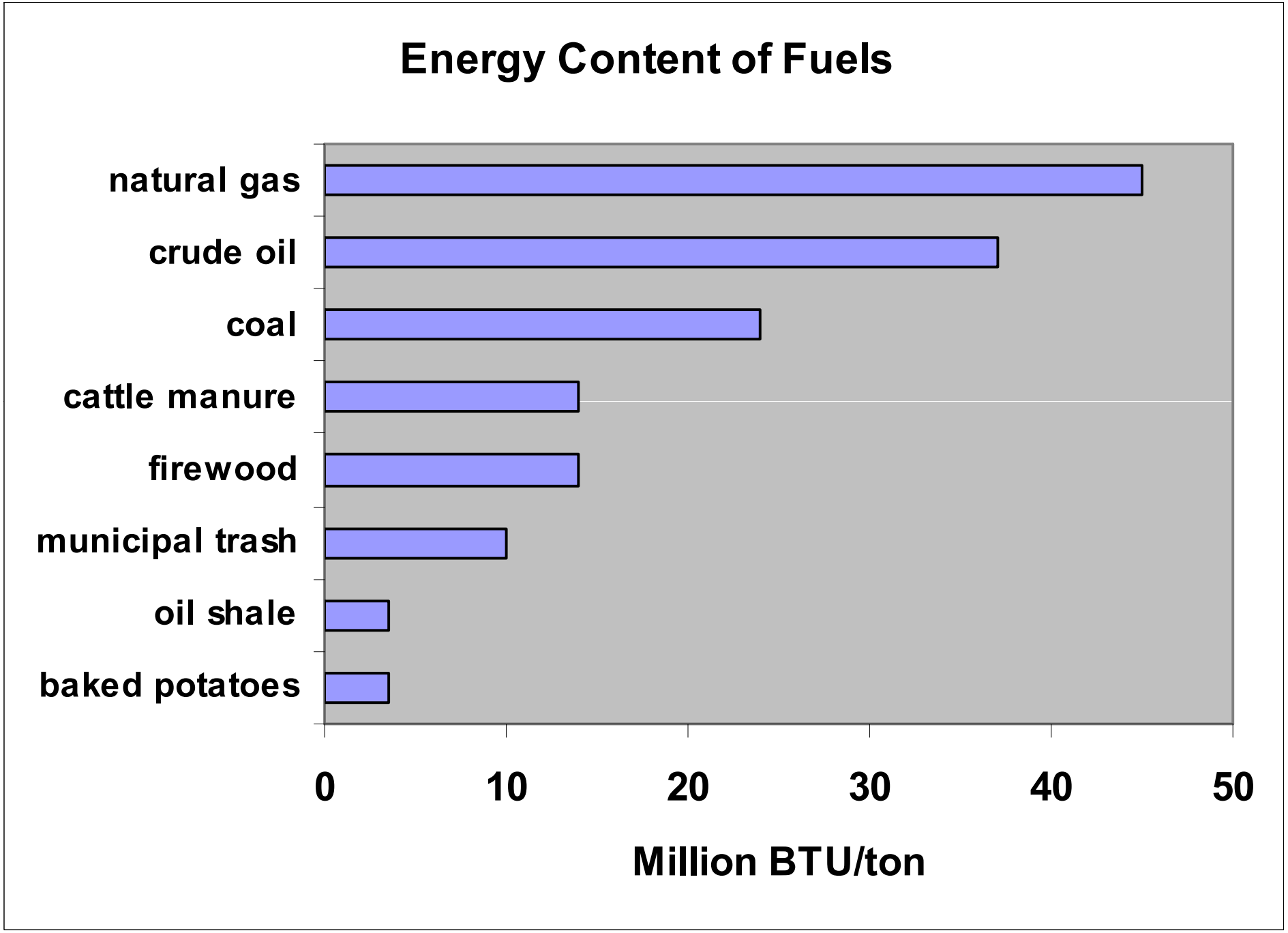
Coal Liquids: 5000 billion

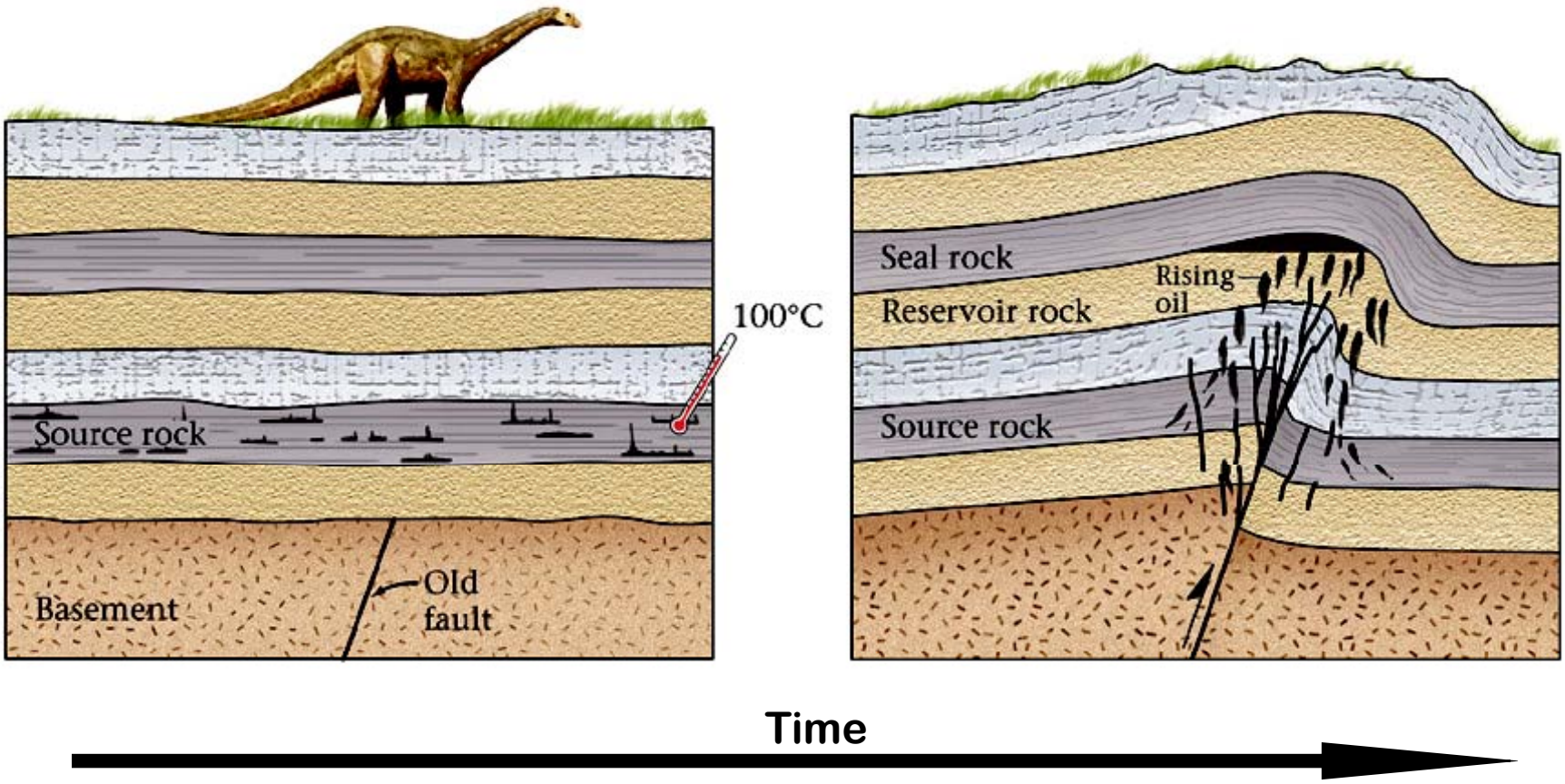
- Dostoevsky in *Crime and Punishment:*
- “Do you think I care if they talk nonsense? Hogwash! I am a man, therefore I talk nonsense. Nobody ever got a single truth without talking nonsense fourteen times first. Maybe even a hundred and fourteen. That’s all right in its own way. We don’t evenknow how to talk nonsense intelligently, though!”

Range of heating values for regional coals (maximum, minimum and average BTU/lb)

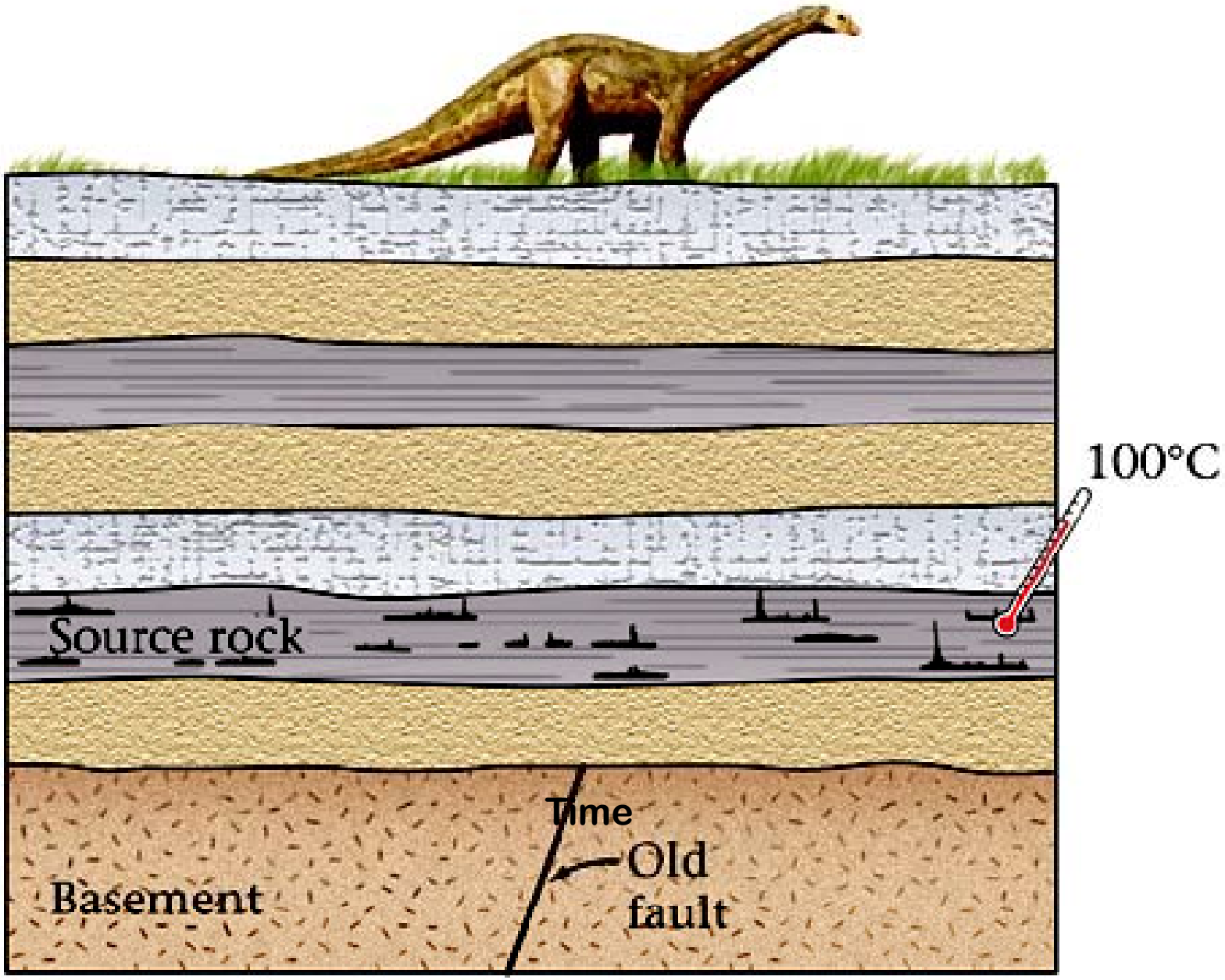


Sources: Colorado Geological Survey, Colorado Coal Quality Data (Information Series 58); USGS, CoalQual Database; USGS Professional Paper 1625-A.


Energy Content of Fuels
natural gas
crude oil
coal
cattle manure
firewood
municipal trash
oil shale
baked potatoes
0
10
20
30
40
50
Million BTU/ton



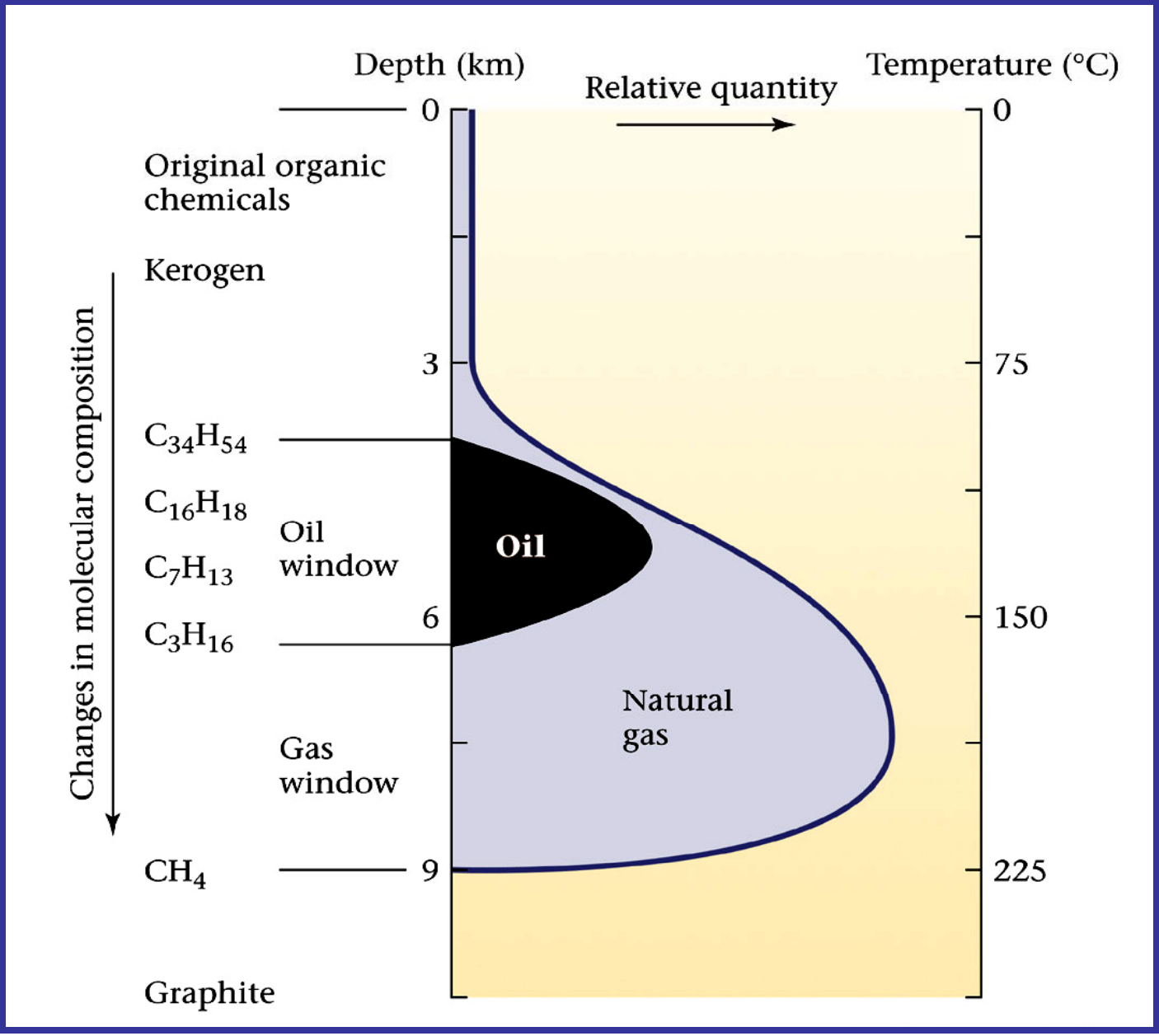
deformation, oil migration
& accumulation in a ‘trap’

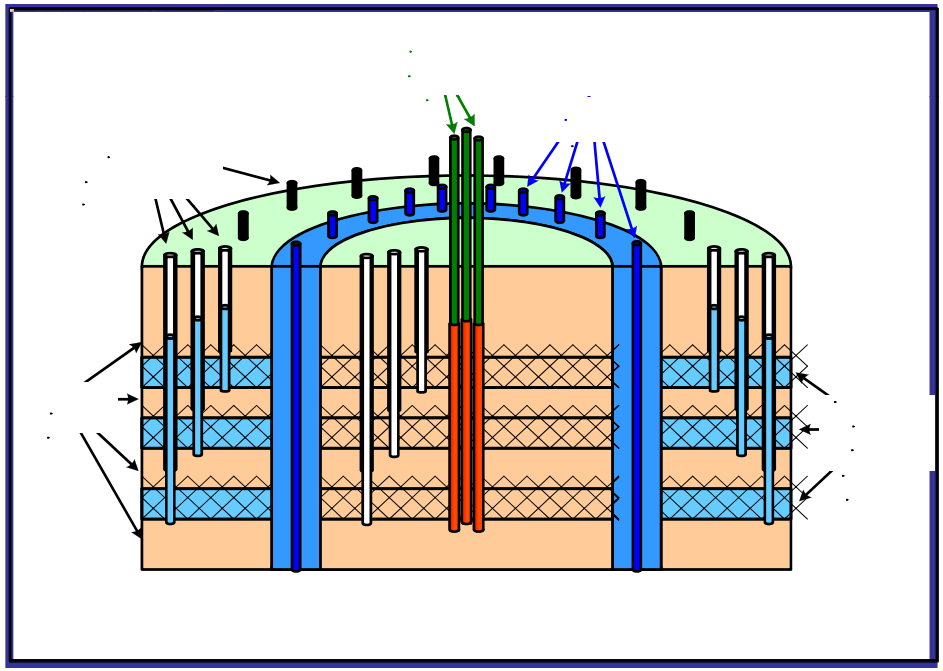

100°C
Source rock
Time
Old
fault
Basement

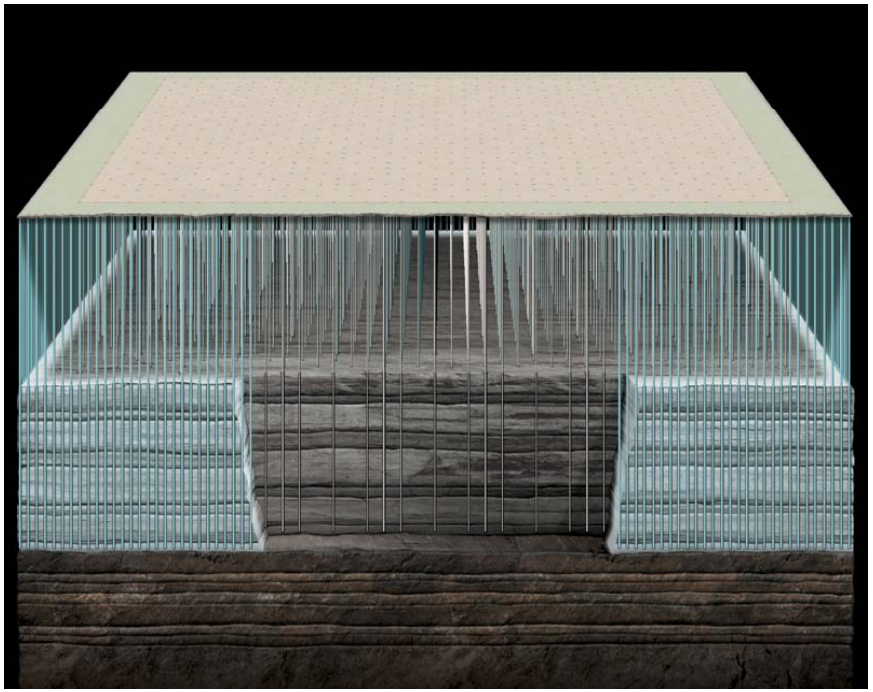
The Petroleum “Kitchen”

‘Oil window’

‘Gas window’

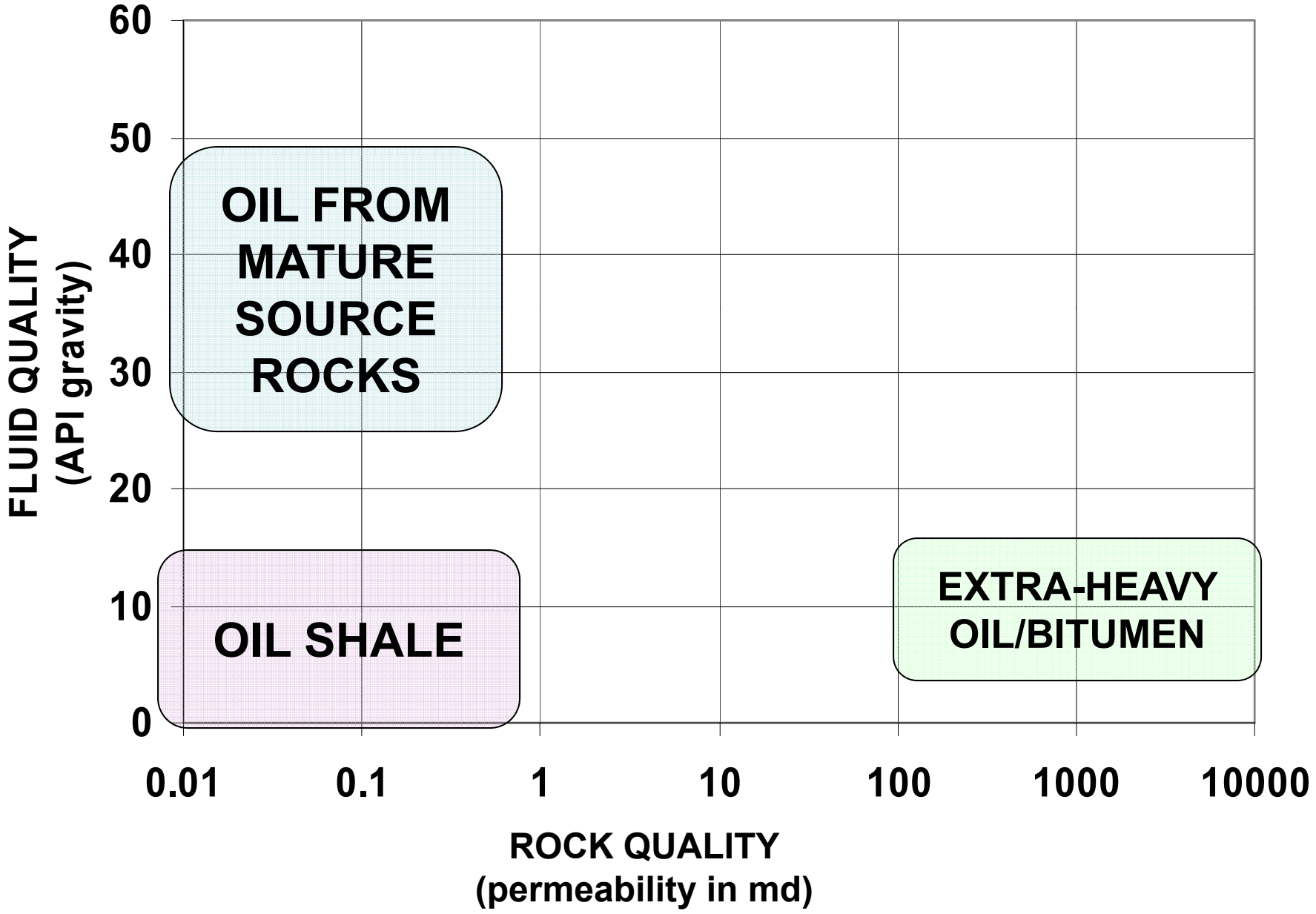


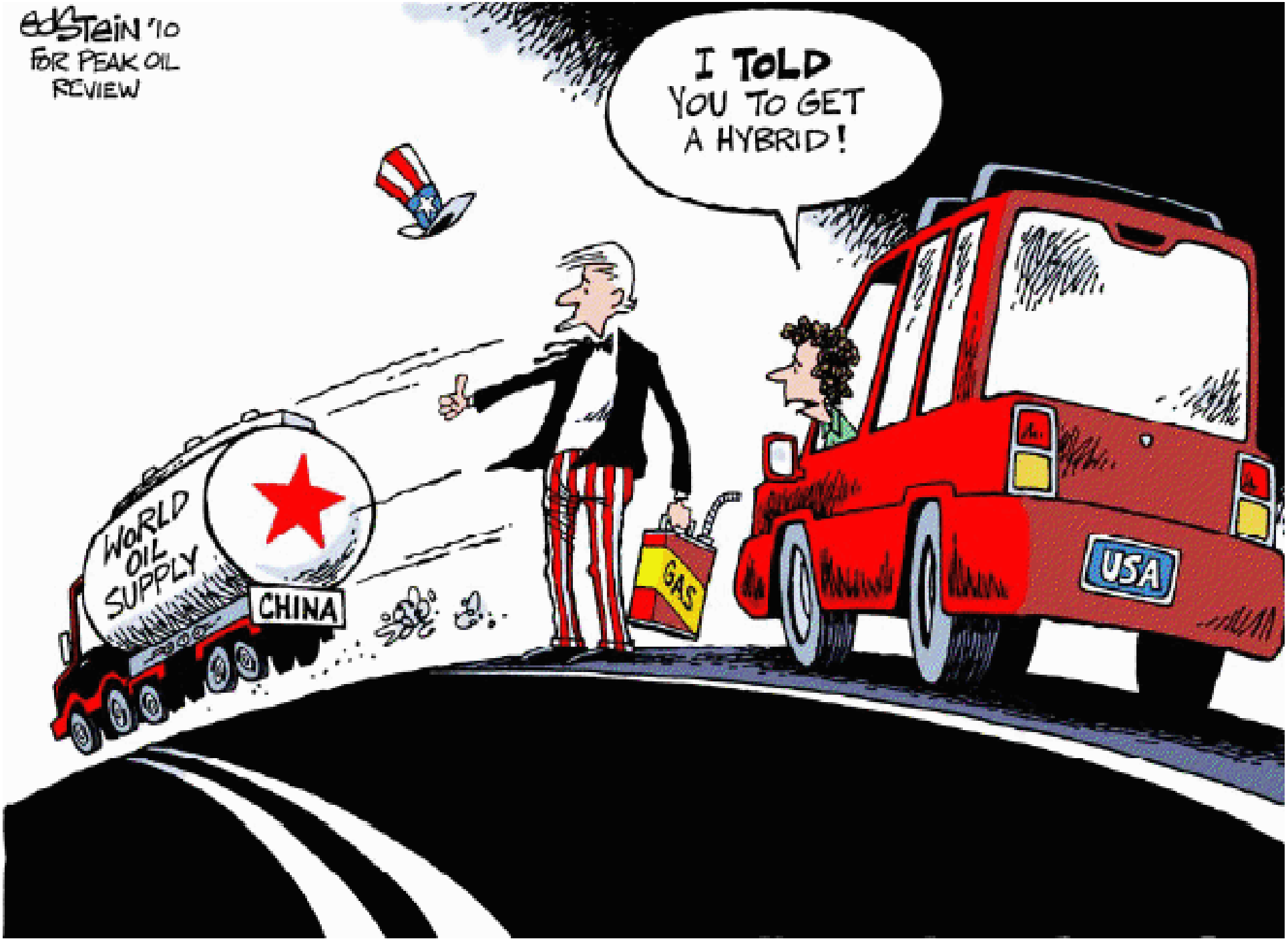




- Do we have the time, capital, carbon, and water to pursue this marginal energy resource? Don’t we have better choices? things to do?
- Is oil shale an idea whose time has passed, whose time will never come, whose time never was, whose time has come, or whose time has passed?

RESOURCE QUALITY AND UNCONVENTIONALS




EdStein '10
FOR PEAK OIL REVIEW
I TOLD YOU TO GET A HYBRID!
WORLD OIL SUPPLY
CHINA
GAS
USA